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(54) **IMAGING DEVICE, APPARATUS AND METHOD FOR PRODUCING THE SAME AND ELECTRONIC APPARATUS**

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H01L 27/146 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 27/14629*** (2013.01); ***H01L 27/1464*** (2013.01); ***H01L 27/14627*** (2013.01); ***H01L 27/14636*** (2013.01); ***H01L 27/14685*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 27/14629; H01L 27/14685; H01L 27/14636; H01L 27/1464; H01L 27/14627
See application file for complete search history.

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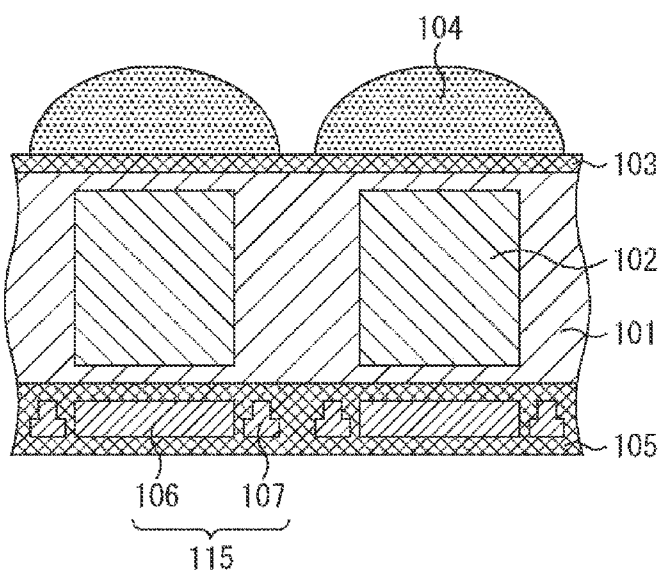
(57) **ABSTRACT**

Solid-state imaging devices, methods to produce the solid-state imaging devices, and electronic apparatuses including the solid-state imaging devices, where the solid-state imaging devices include a semiconductor substrate including a light receiving surface; a plurality of photoelectric conversion parts provided within the semiconductor substrate; and a plurality of reflection portions provided in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface; where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

20 Claims, 19 Drawing Sheets



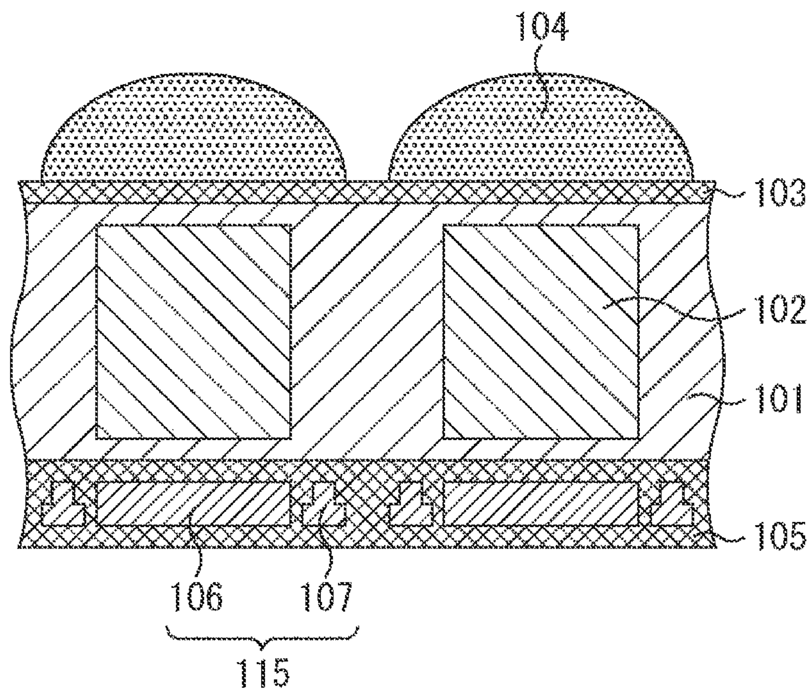


FIG.1

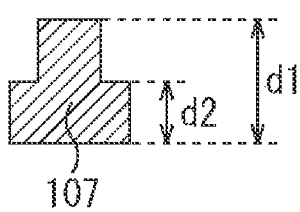


FIG.2

FIG.3A

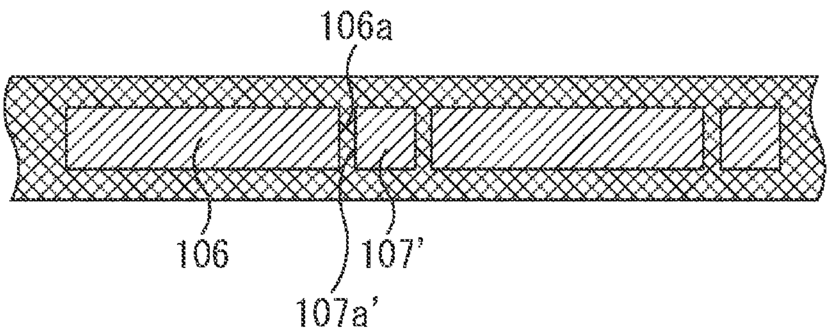


FIG.3B

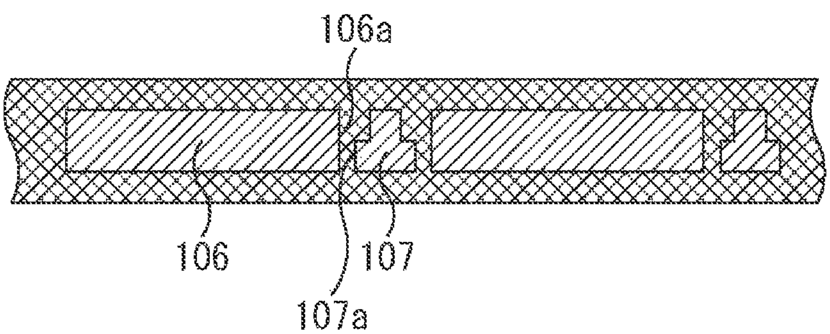


FIG.3C

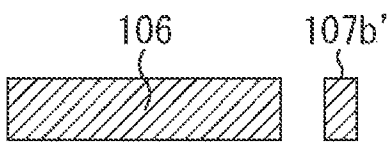


FIG.3D

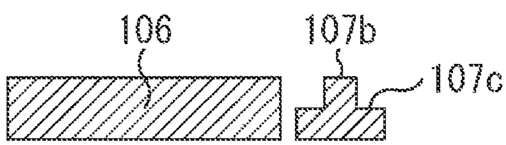


FIG.4A

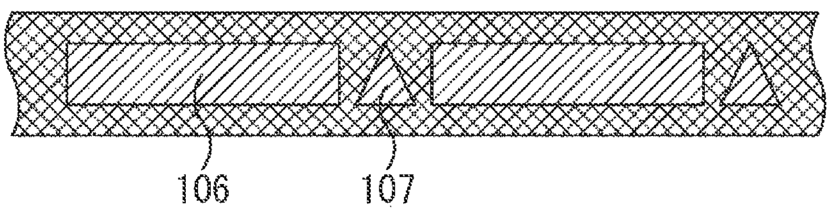
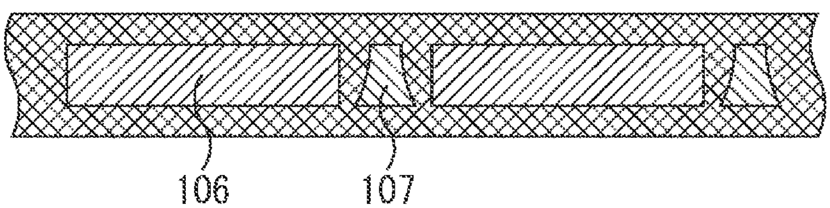


FIG.4B



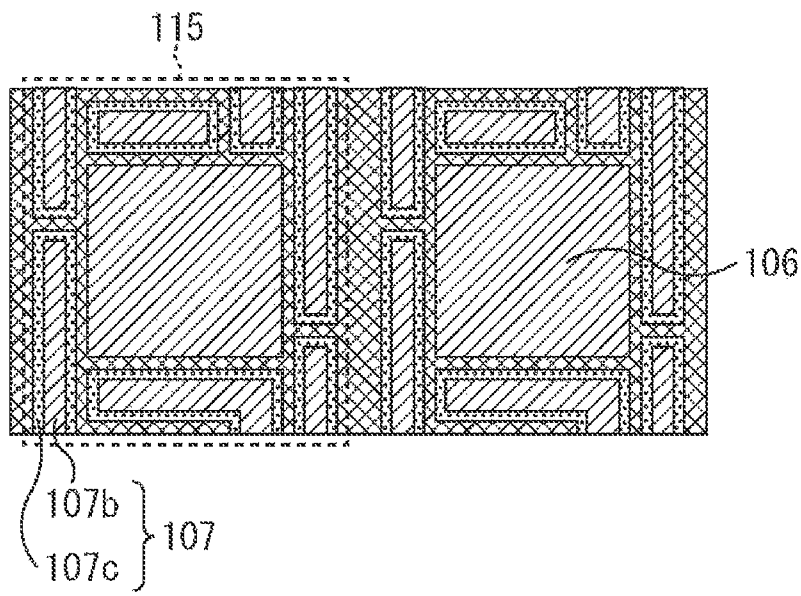


FIG.5

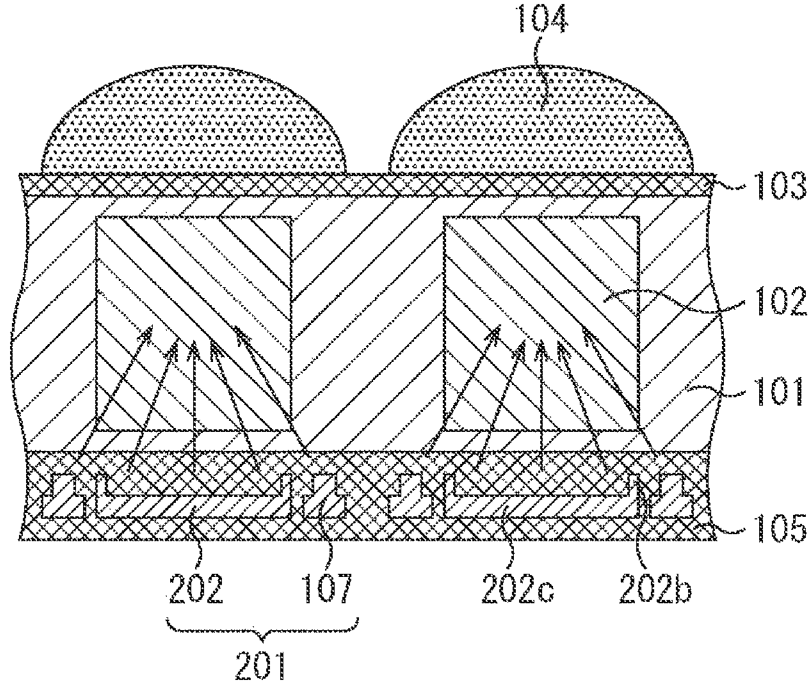

104
103
102
101
105
202
107
202c
202b
201

FIG.6A

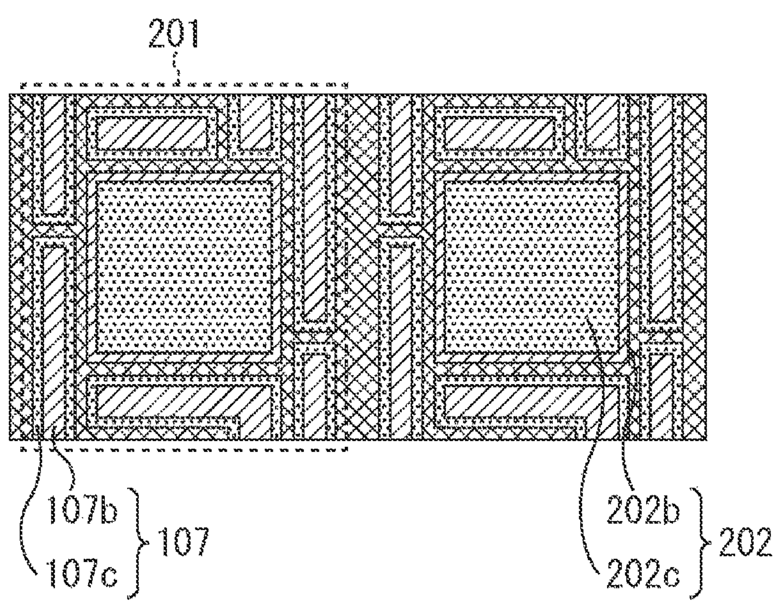

201
107b
107c
107
202b
202c
202

FIG.6B

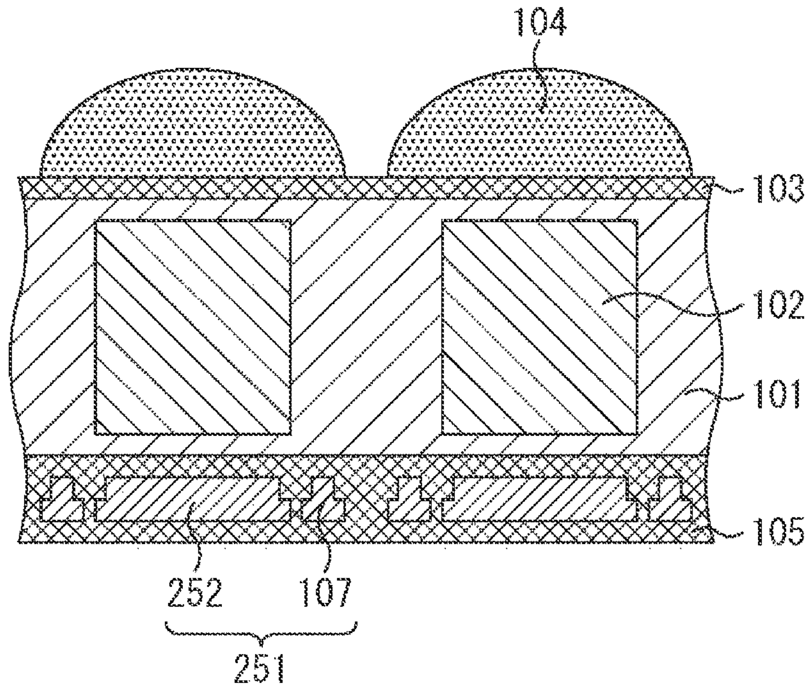


FIG.7A

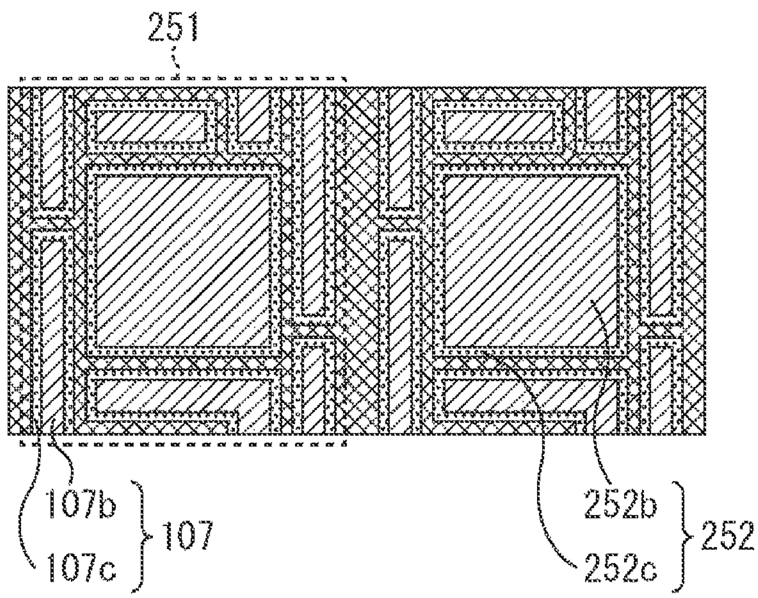


FIG.7B

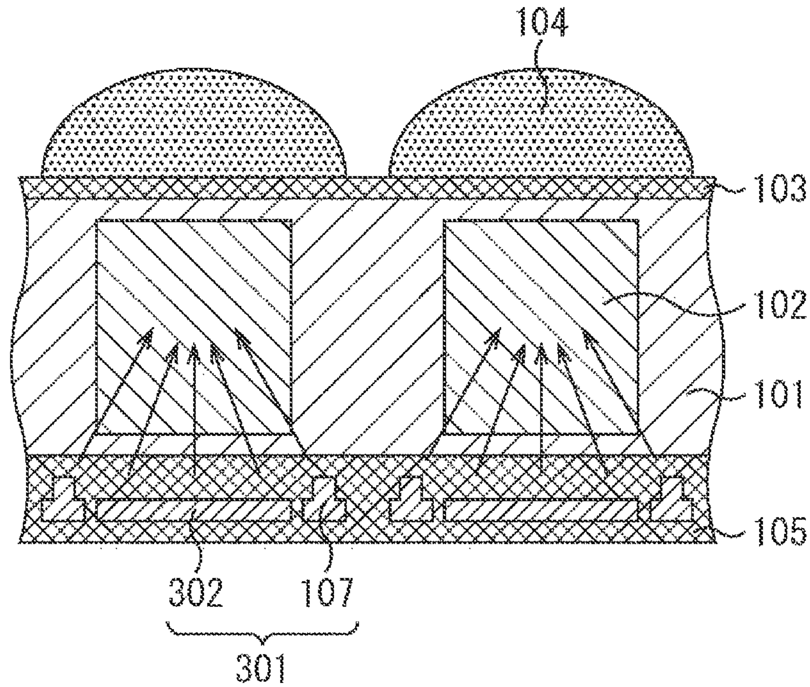


FIG.8A

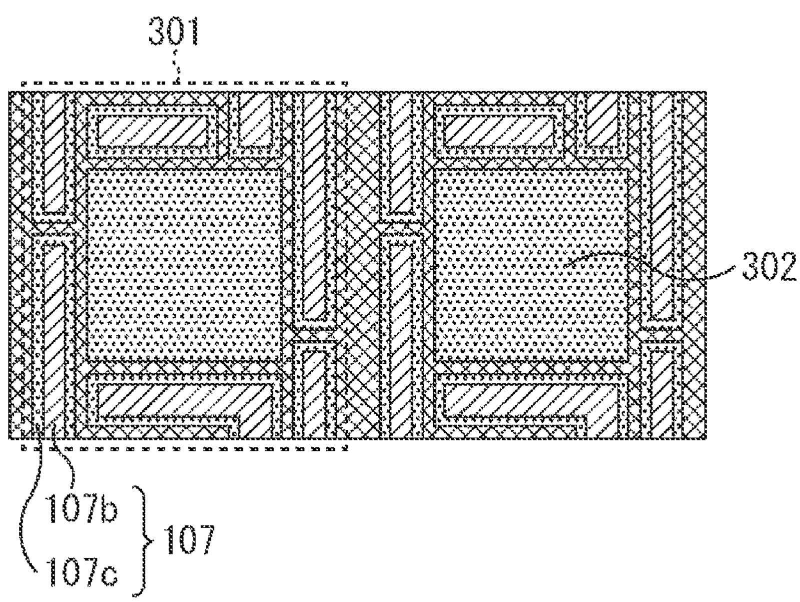


FIG.8B

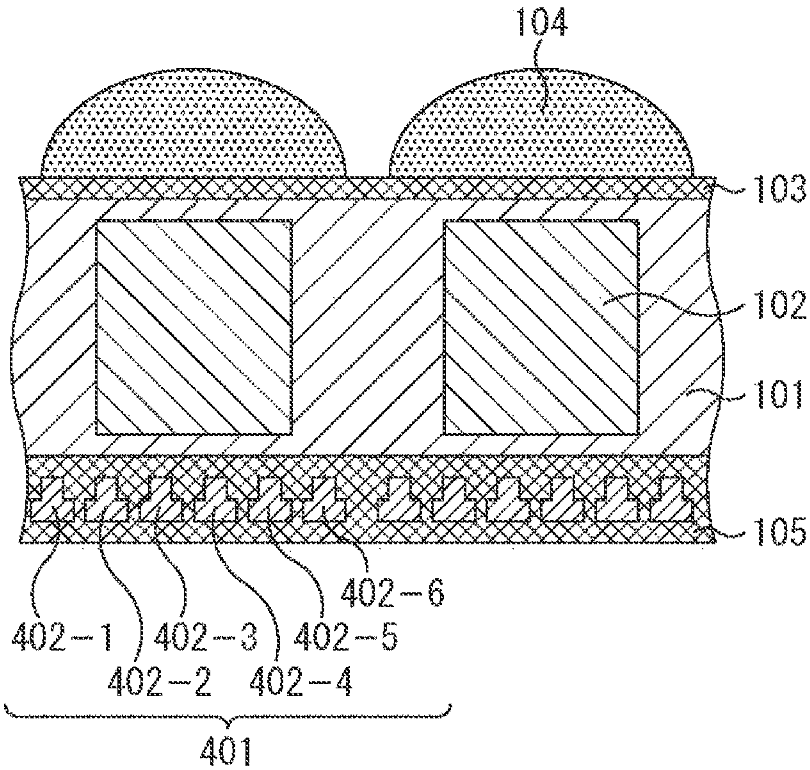

104
103
102
101
105
402-6
402-1
402-3
402-5
402-2
402-4
401

FIG.9A

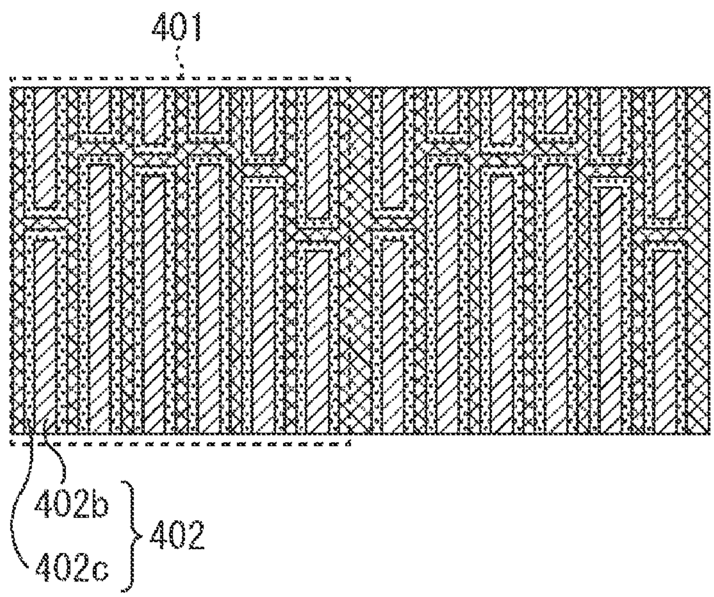

401
402b
402c
402

FIG.9B

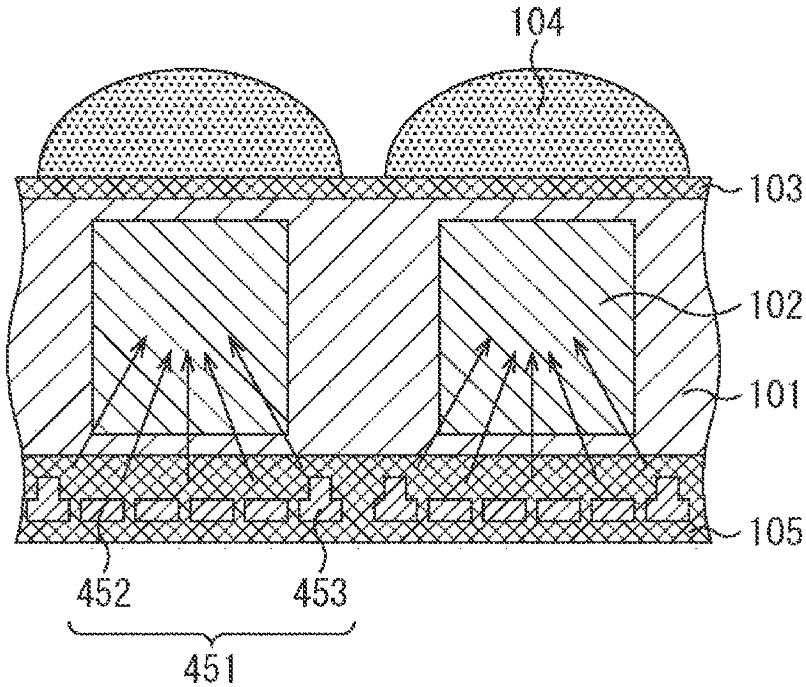


FIG.10A

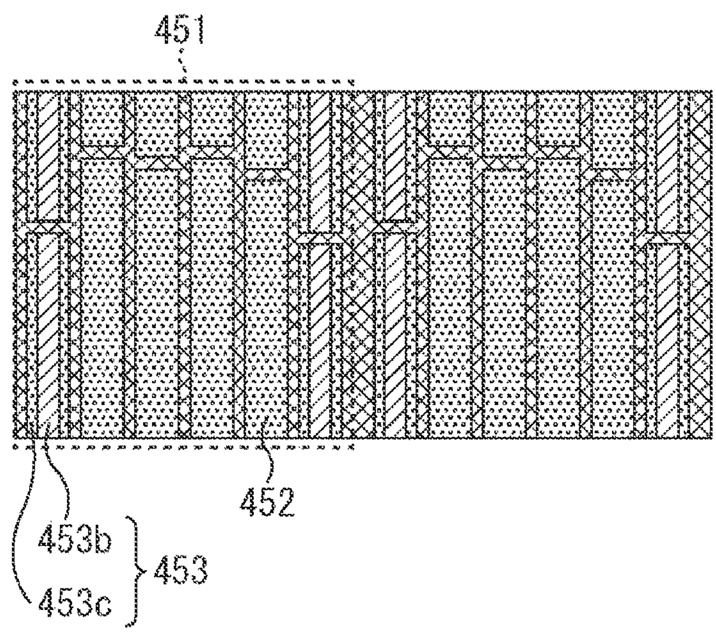


FIG.10B

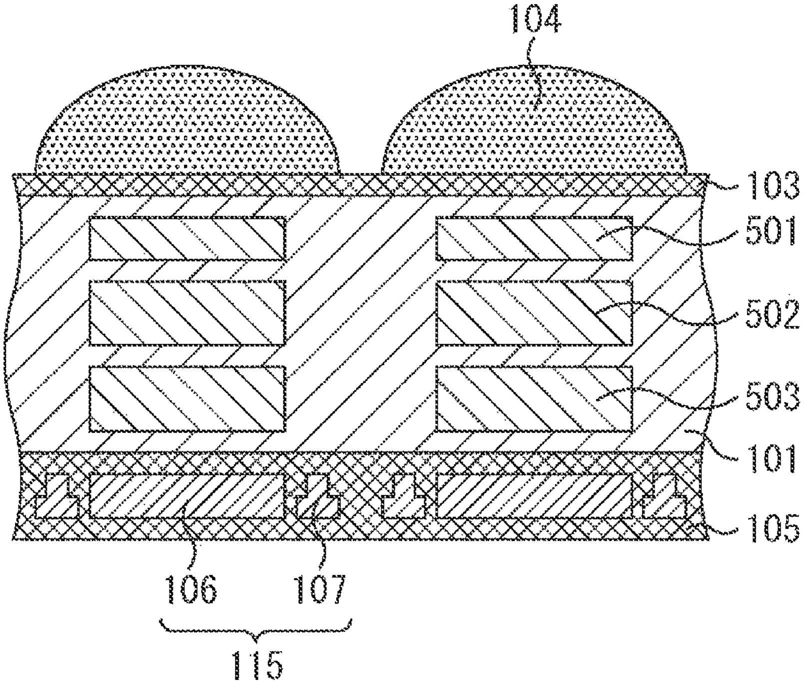


FIG.11A

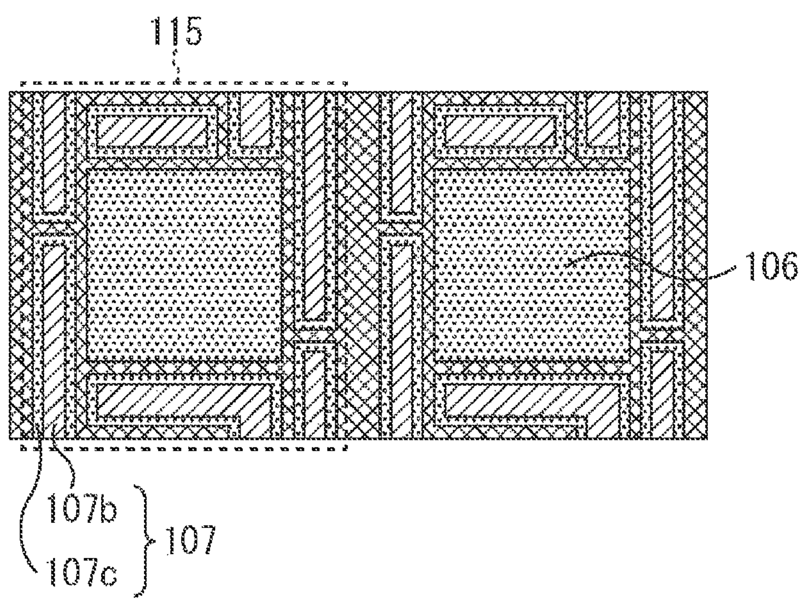


FIG.11B

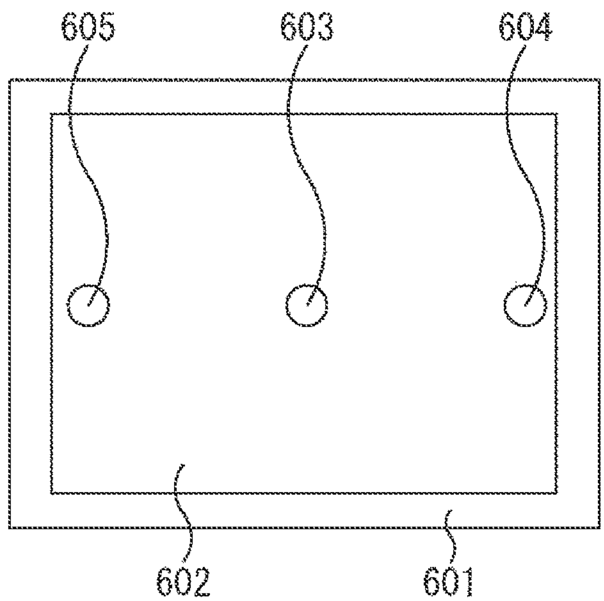


FIG.12

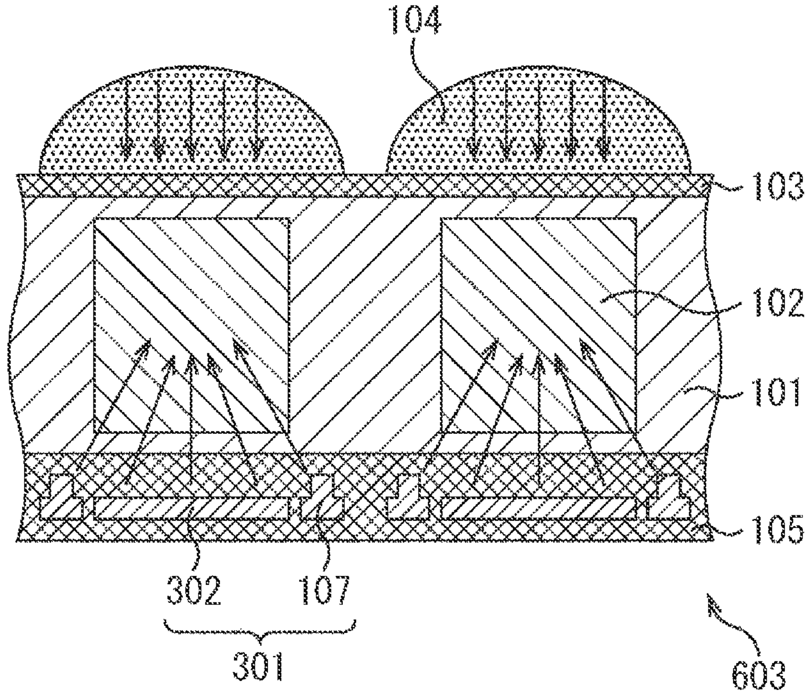


FIG.13A

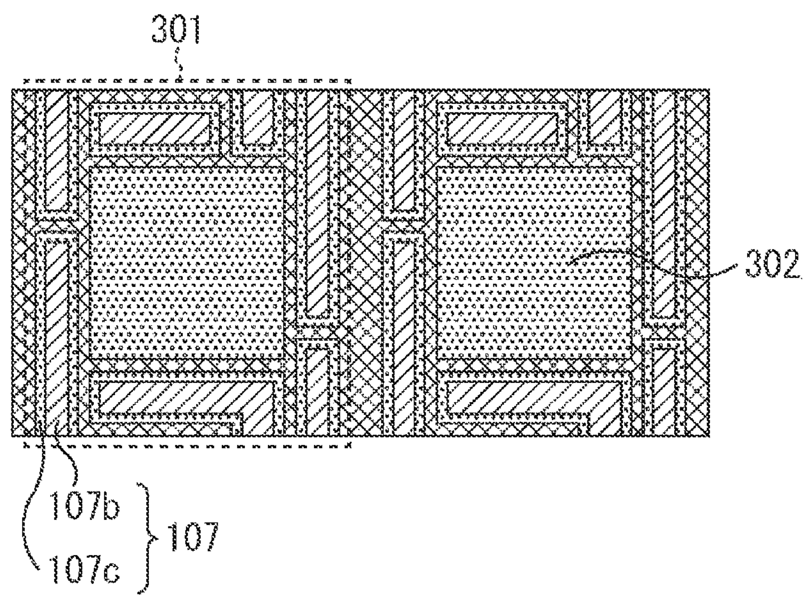


FIG.13B

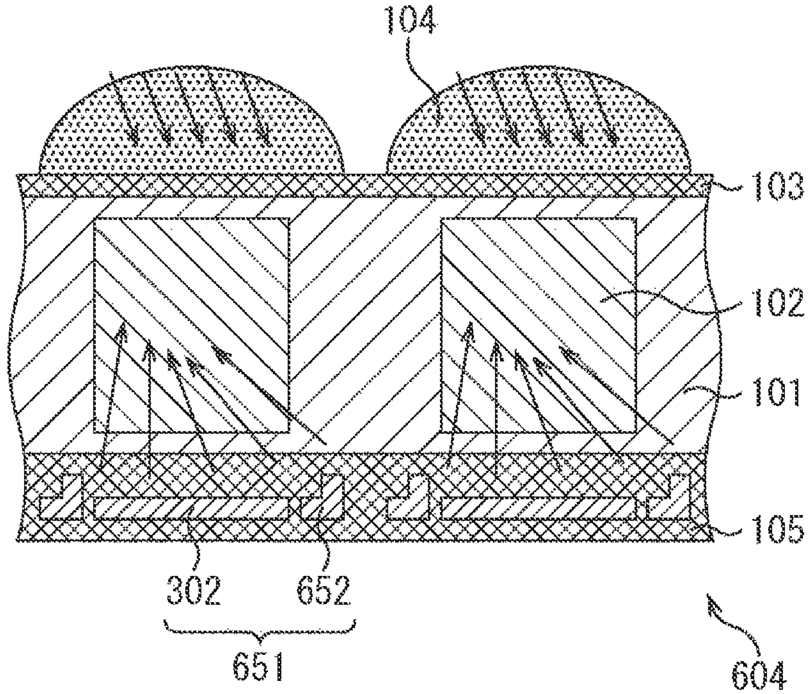


FIG.14A

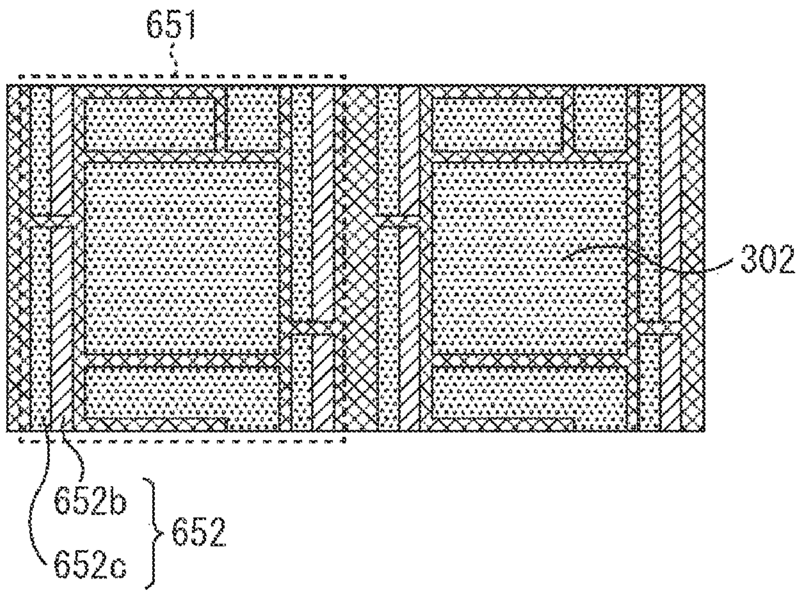


FIG.14B

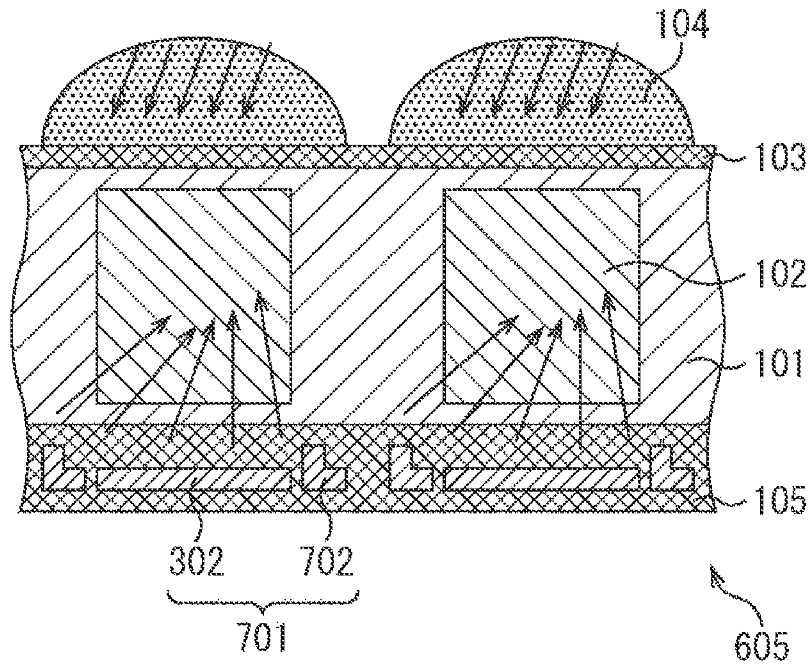


FIG.15A

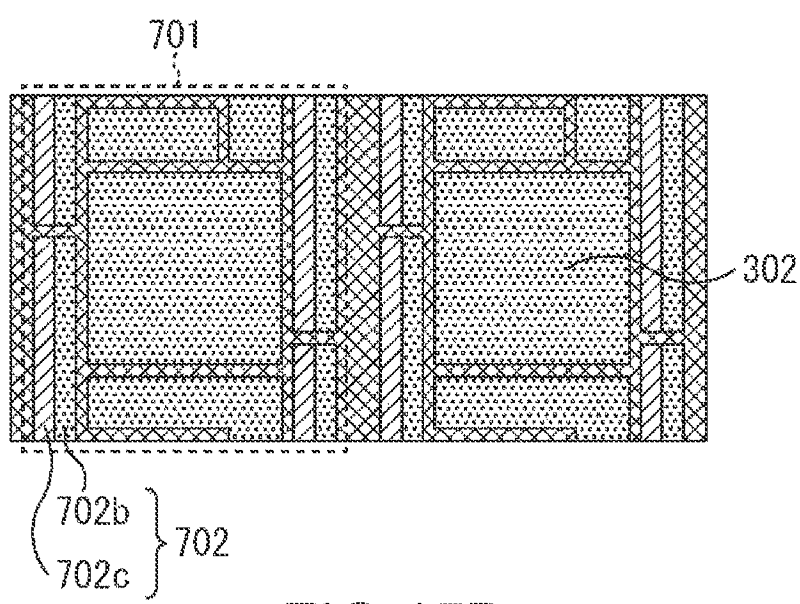


FIG.15B

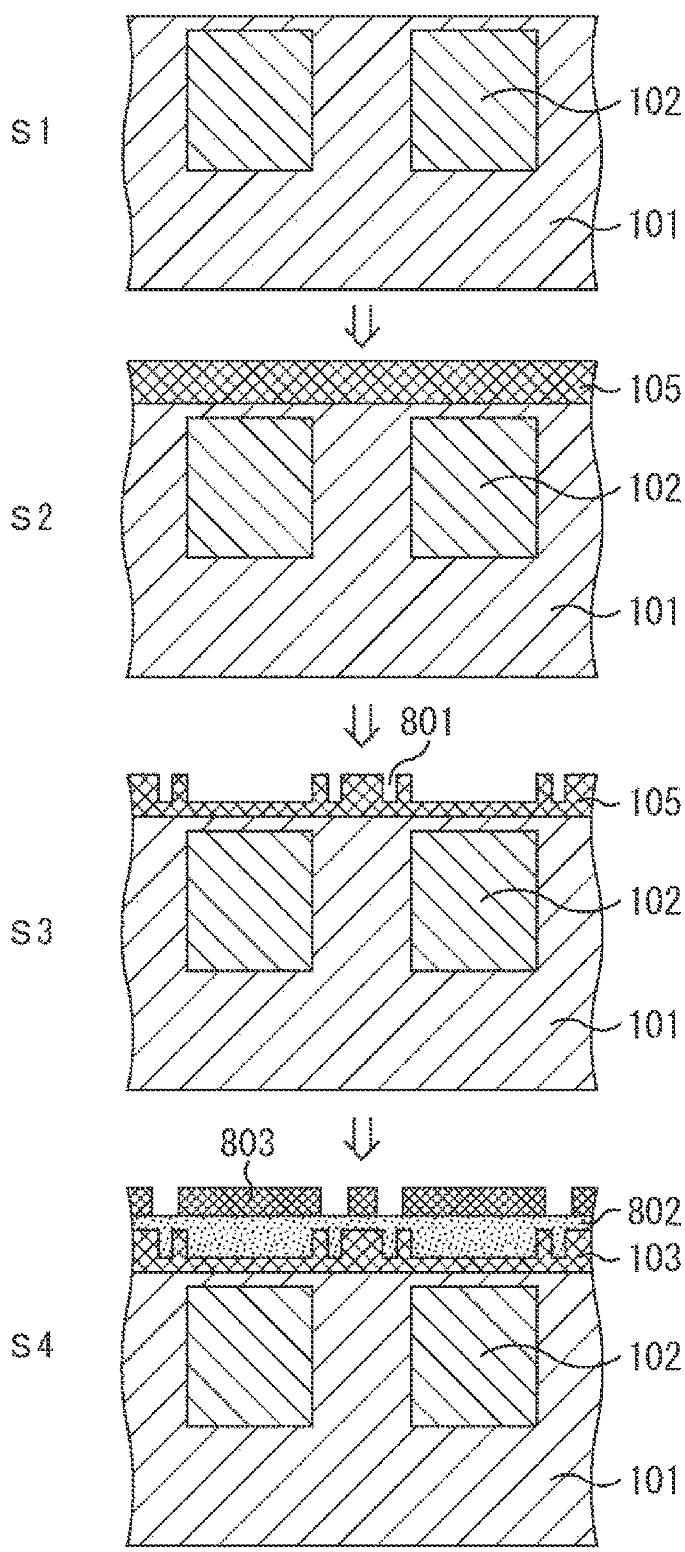
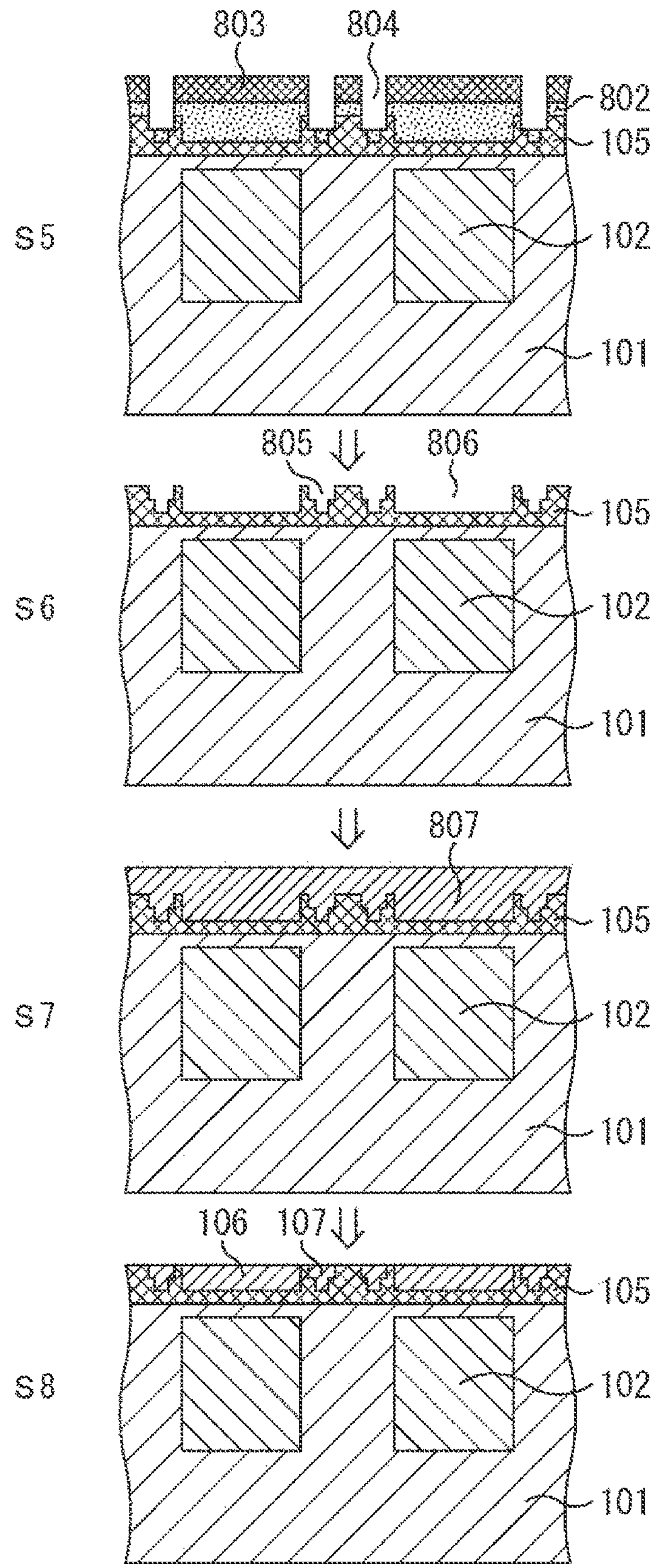

S1
102
101
105
S2
102
101
801
105
S3
102
101
803
802
103
S4
102
101

FIG.16


803
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S5
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S7
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106
107
105
S8
102
101

FIG.17

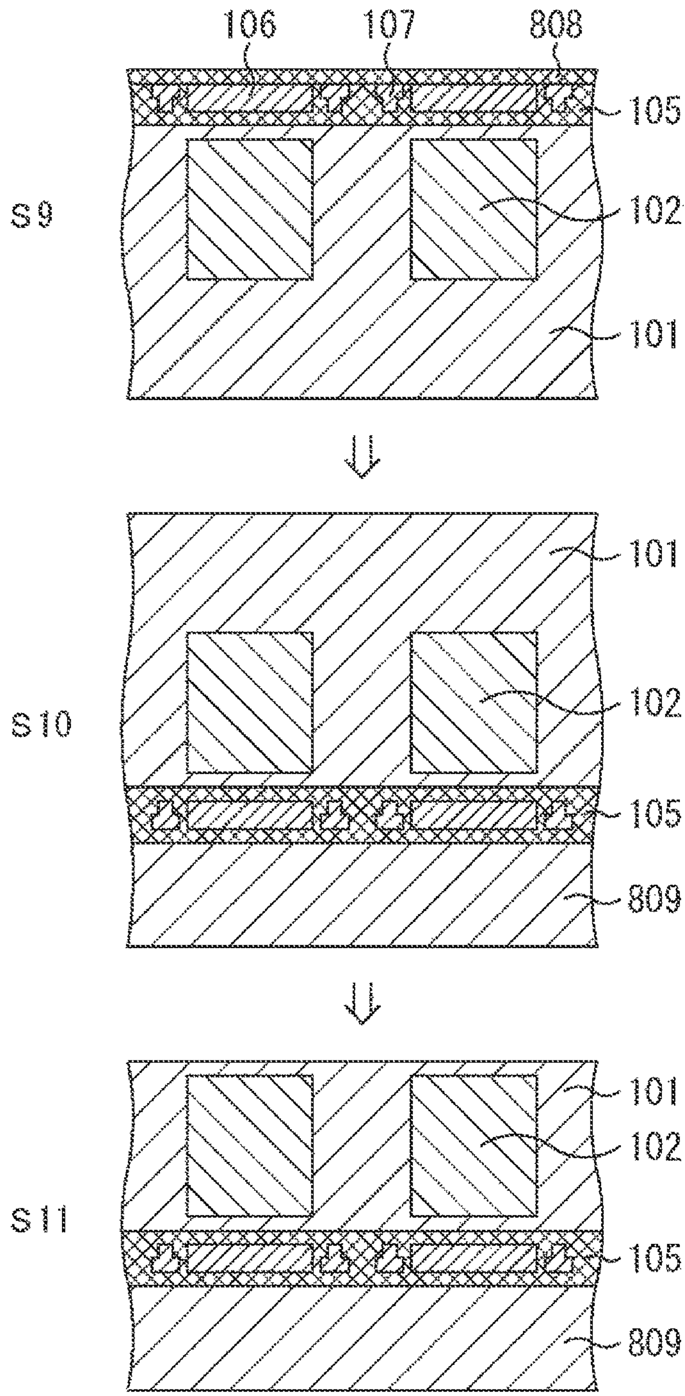
106
107
808
105
S9
102
101
101
S10
102
105
809
101
102
S11
105
809

FIG.18

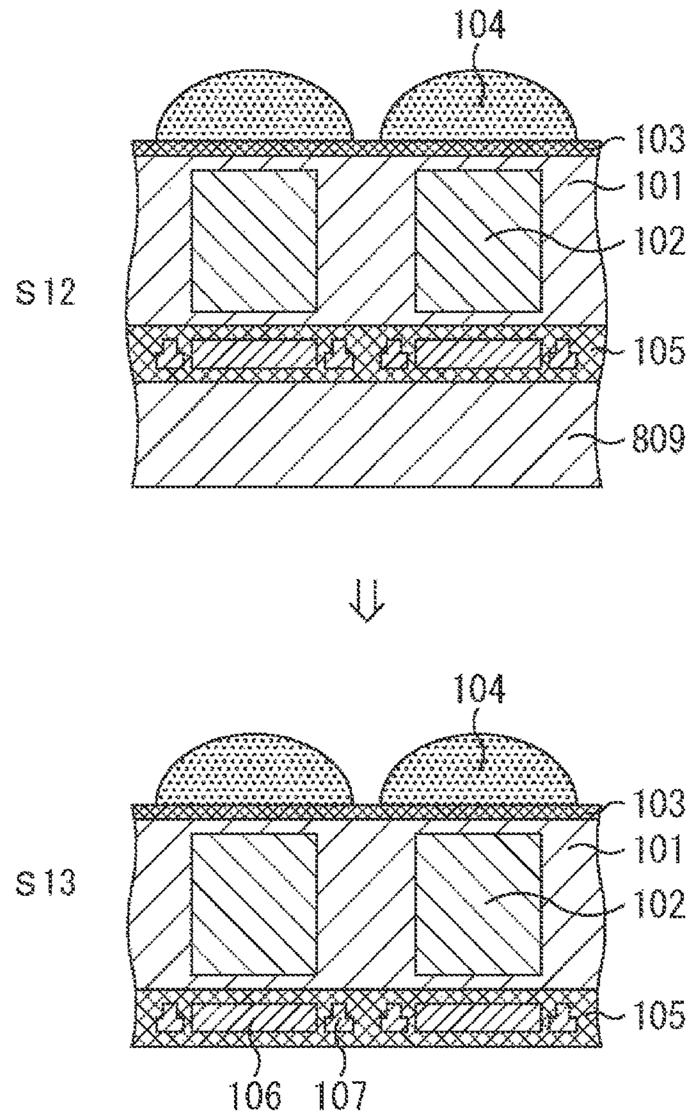

FIG.19

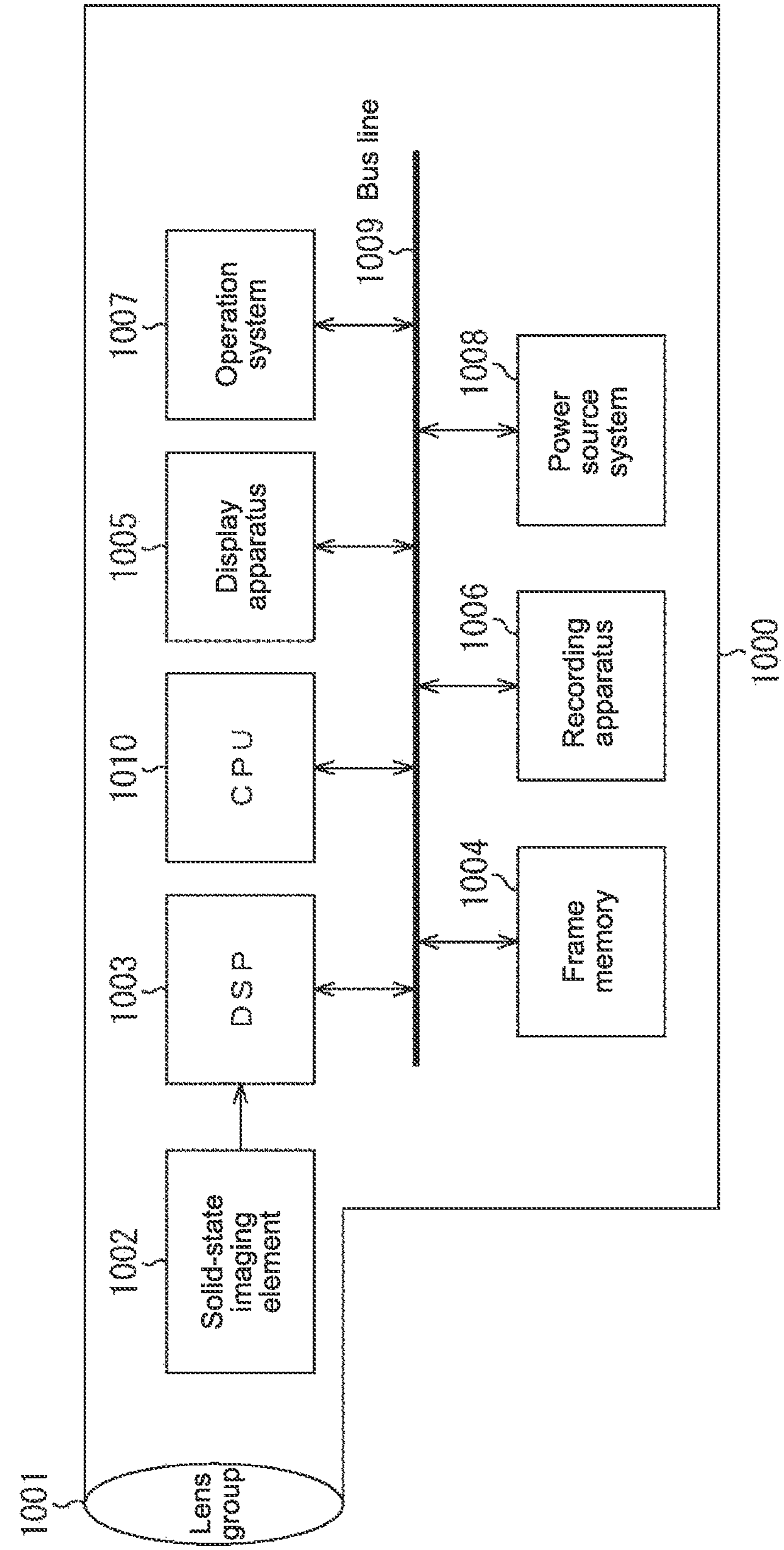
1001
Lens group
1002
Solid-state imaging element
1003
D S P
1010
C P U
1005
Display apparatus
1007
Operation system
1009
Bus line
1004
Frame memory
1006
Recording apparatus
1008
Power source system
1000

FIG.20

IMAGING DEVICE, APPARATUS AND METHOD FOR PRODUCING THE SAME AND ELECTRONIC APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Japanese Priority Patent Application JP 2013-186980 filed Sep. 10, 2013, the entire content of which is incorporated herein by reference.

BACKGROUND

The present disclosure relates to imaging devices, apparatuses and methods for producing the imaging devices, and electronic apparatuses. More specifically, the present disclosure relates to imaging devices suitable for enhancing the sensitivity, apparatuses and methods for producing such imaging devices, and electronic apparatuses suitable for enhancing the sensitivity.

In recent years, imaging devices having two-dimensionally arranged CCDs (charge coupled devices), CMOS (complementary metal-oxide semiconductor) elements or the like have been used in digital video cameras, digital still cameras, and so on. Typically, an imaging device is produced by forming a photoelectric conversion part or a diffusion layer to a substrate by dopant introduction such as ion implantation; and then forming a wiring layer and an insulating film by depositing and processing a film. Light entering the imaging device would be absorbed by the photoelectric conversion part and converted into electric charges. By storing these electric charges in the photoelectric conversion part, and by detecting total amount of the charges being stored, a signal according to incident light intensity would be obtained.

However, if a penetration length of the incident light is greater than a thickness of the substrate, the incident light would not be sufficiently absorbed by the photoelectric conversion part. Light utilization efficiency may therefore be decreased. An example of a way of allowing enhancement of sensitivity by allowing long-wavelength light being transmitted through the photoelectric conversion part to be effectively converted into electric charges, has been suggested in Japanese Patent Application Laid-Open No. 2008-147333 (hereinafter referred to as "Patent Document 1").

SUMMARY

In the imaging device according to Patent Document 1, a reflection plate is made of the same material as a metal wiring layer. The metal wiring layer may be used as a connecting wiring of the amplifier transistor for taking out photoelectric conversion signals, or the like.

The regions where the reflection plate can be formed are other than the regions provided with the wirings, so the layout area would be limited. Because of that, there has been a limit in a reflection efficiency of the reflection plate for reflecting light.

In addition, in cases where the light enters the reflection plate from an oblique direction and the incidence angle of the light is relatively large, the light may enter the regions out of the region where the reflection plate has been formed. It may thus fail to obtain a sufficient effect of the reflection plate and result in significant changes in the sensitivity characteristics, which changes may depend on the incidence angle of the light.

It has been desired to enhance sensitivity characteristics of imaging devices.

In view of the above-mentioned circumstances, it may be desirable to allow enhancement of the sensitivity characteristics.

According to various embodiments of the present disclosure, there is provided solid-state imaging devices, including: a semiconductor substrate including a light receiving surface; a plurality of photoelectric conversion parts provided within the semiconductor substrate; and a plurality of reflection portions provided in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface; where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

According to further various embodiments of the present disclosure, there is provided methods of manufacturing an imaging device, the method including: providing a semiconductor substrate having a light receiving surface and a plurality of photoelectric conversion parts within the semiconductor substrate; and providing a plurality of reflection portions in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface; where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

According to still further various embodiments of the present disclosure, there is provided electronic apparatuses omc;idomg: an imaging device including: a semiconductor substrate including a light receiving surface; a plurality of photoelectric conversion parts provided within the semiconductor substrate; and a plurality of reflection portions provided in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface; where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

As described above, an embodiment of the present disclosure may make it possible to increase an amount of light that the imaging device receives, and allow enhancement of the sensitivity.

It should be noted that the effects described herein are non-limitative examples. For example, any one of the effects described herein may be an effect according to an embodiment of the present disclosure.

These and other objects, features and advantages of the present disclosure will become more apparent in light of the following detailed description of best mode embodiments thereof, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a cross-sectional view showing a pixel structure of an imaging device of a first embodiment;

FIG. **2** is a figure for illustrating a shape of a metal wiring;

FIGS. **3**A to **3**D are figures for illustrating a difference in parasitic capacitances due to a difference in metal wirings;

FIGS. **4**A and **4**B are figures for illustrating other shapes of the metal wiring;

FIG. **5** is a plan view showing a configuration of a reflection portion of the imaging device of the first embodiment;

FIGS. **6**A and **6**B are figures showing a pixel structure of an imaging device of a second embodiment;

FIGS. **7**A and **7**B are figures showing a pixel structure of an imaging device of a third embodiment;

FIGS. **8**A and **8**B are figures showing a pixel structure of an imaging device of a fourth embodiment;

FIGS. **9**A and **9**B are figures showing a pixel structure of an imaging device of a fifth embodiment;

FIGS. **10**A and **10**B are figures showing a pixel structure of an imaging device of a sixth embodiment;

FIGS. **11**A and **11**B are figures showing a pixel structure of an imaging device of a seventh embodiment;

FIG. **12** is a figure showing a chip layout of an imaging device of an eighth embodiment;

FIGS. **13**A and **13**B are figures showing a pixel structure of an imaging device of the eighth embodiment;

FIGS. **14**A and **14**B are figures showing another pixel structure of an imaging device of the eighth embodiment;

FIGS. **15**A and **15**B are figures showing still another pixel structure of an imaging device of the eighth embodiment;

FIG. **16** is a figure showing a process of the production of an imaging device;

FIG. **17** is a figure showing a process of the production of the imaging device;

FIG. **18** is a figure showing a process of the production of the imaging device;

FIG. **19** is a figure showing a process of the production of the imaging device; and

FIG. **20** is a figure for illustrating a structure of an electronic apparatus.

DETAILED DESCRIPTION OF EMBODIMENTS

Hereinafter, embodiments of the present disclosure (each of which will be referred to herein as an "embodiment") will be described with reference to the drawings. The description will be given in the following order:

1. Configuration of Imaging Device of First Embodiment
2. Configuration of Imaging Device of Second Embodiment
3. Configuration of Imaging Device of Third Embodiment
4. Configuration of Imaging Device of Fourth Embodiment
5. Configuration of Imaging Device of Fifth Embodiment
6. Configuration of Imaging Device of Sixth Embodiment
7. Configuration of Imaging Device of Seventh Embodiment
8. Configuration of Imaging Device of Eighth Embodiment
9. Process of Production of Imaging Device
10. Electronic Apparatus

[Configuration of Imaging Device of First Embodiment]

FIG. **1** is a cross-sectional view showing a pixel structure of an imaging device having a reflection portion of a first embodiment of the present disclosure. In the following description, adjacent two pixels are shown in the figure, and these pixels are arranged in the rows and columns in a matrix of an arbitrary number of pixels. In addition, in the following, although a back-illuminated imaging device is illustrated as an example, the following description does not imply that the present disclosure applies only to back-illuminated imaging devices.

In the pixel structure shown in FIG. **1**, some microlenses **104** are formed on an interlayer insulating film **103**, over a silicon substrate **101** in which photoelectric conversion parts **102** are formed. Further, in a surface opposite to a light incidence surface provided with the microlenses **104**, metal wirings **107** used for reading signal charges and applying voltages to each part are disposed.

Still further, in the same layer as the metal wirings **107**, a reflection plate **106** is also disposed. As used herein, the term "same layer" may mean that at least one side of the reflection plate and the metal wirings are disposed at the same depth of the semiconductor substrate. In addition, the term "same layer" may mean that the reflection plate **106** and the metal wirings **107** are each a single layer within the same layer, that the reflection plate **106** and the metal wirings **107** do not overlap, or do not overlap in a vertical direction, and/or are at a same vertical height or distance A reflection portion **115** is made up of the reflection plate **106** and the metal wirings **107**.

The metal wirings **107** may be formed separated from the reflection plate **106**, by a space narrow enough so that passage therethrough of incident light would be inhibited. In addition, each metal wiring **107** has a relatively small film thickness in its part adjacent to the metal wiring **107** of an adjacent pattern thereto, as will be described later. For example, the distance between the reflection plate **106** and the metal wiring **107** may be 0.25 micrometers or less.

The reflection plate **106** may be formed by a metal film. The reflection plate **106** is provided for reflecting the light being transmitted through the silicon substrate **101** and allowing the light to enter the photoelectric conversion part **102** again. In this way, by providing the reflection plate **106**, it makes it possible to increase an amount of light entering the photoelectric conversion part **102**, and allow enhancement of the sensitivity.

Further, the metal wirings **107** are also formed by a metal, and as described above, used for reading signal charges and applying voltages to each part are disposed. The metal wirings also have a function of reflecting the light being transmitted through the silicon substrate **101** and allowing the light to enter the photoelectric conversion part **102** again.

Now, since the reflection plate **106** and the metal wirings **107** have the same function of reflecting the light being transmitted through the silicon substrate **101** and allowing the light to enter the photoelectric conversion part **102** again, the reflection plate **106** and the metal wirings **107** will be collectively referred to as the "reflection portion **115**", as appropriate.

In order to effectively reflect the light that has transmitted through the silicon substrate **101** to the photoelectric conversion part **102**, the size of the reflection portion **115** may be made as large as possible. In order to provide a larger size of the reflection portion **115** that includes the reflection plate **106** and the metal wirings **107**, the reflection plate **106** and one or more of the metal wirings **107** may be formed together as one sheet of metal film, or the reflection plate **106** and the metal wiring **107** may be placed as close to each other as possible, instead of placing them separated from each other as shown in FIG. **1**.

However, if the reflection plate **106** and the metal wirings **107** were to be formed together as one sheet of metal film, the metal wirings **107** would no longer function as a wiring. Therefore, it may be necessary that the reflection plate **106** and the metal wiring **107** be provided separated from each other. Between the reflection plate **106** and the metal wiring **107**, an insulating film **105** may be provided. Thus, in cases where the reflection plate **106** and the metal wiring **107** are to be provided separated from each other, the size of the reflection portion **115** may be largest when the reflection plate **106** and the metal wiring **107** are placed in close proximity, but not in contact, with each other.

Yet, when the reflection plate **106** and the metal wiring **107** are placed in close proximity, a parasitic capacitance may appear between the reflection plate **106** and the metal wiring **107**. In order to minimize the parasitic capacitance, the reflection plate **106** and the metal wiring **107** may be placed at some distance from each other.

Accordingly, a shape of each metal wiring **107** may be one as shown in FIG. **1**. The metal wiring **107** has a stepped shape as viewed in a cross section. In FIG. **1**, the metal wiring **107** has a shape in which two squares, large and small, are combined. A small square-shape metal wiring **107** is provided on the microlens **104** side of a large square-shape metal wiring **107** lying underneath.

FIG. **2** shows the metal wiring **107** separately. As the metal wiring **107** is a metal film, the shape of the metal wiring **107** will hereinafter be described by film thickness. As shown in FIG. **2**, the metal wiring **107** has two types of film thicknesses. The larger film thickness is a thickness d1 and the smaller film thickness is a thickness d2. Both edge parts of the metal wiring **107** have a film thickness of d2. A center part of the metal wiring **107** has a film thickness of d1.

In the description above, the "small square-shape metal wiring **107**" corresponds to the part having a film thickness of (d1-d2), and represents the square shape having a height corresponding to the thickness (d1-d2). The "large square-shape metal wiring **107**" corresponds to the part having a film thickness of d2, and represents the square shape having a height corresponding to the thickness d2.

Hereinafter, the part having a film thickness of d1 will be referred to as a "first film thickness part" and the part having a film thickness of d2 will be referred to as a "second film thickness part", as appropriate.

Referring back to FIG. **1**, it can be seen that the first film thickness part of the metal wiring **107**, which has the film thickness of d1, is located relatively distant from the reflection plate **106**; and the second film thickness part of the metal wiring **107**, which has the film thickness of d2, is located relatively close to the reflection plate **106**. With such a configuration that includes a part where a distance between the reflection plate **106** and the metal wiring **107** is short and a part where the distance is long, it makes it possible to reduce the parasitic capacitance that appears between the reflection plate **106** and the metal wiring **107**.

FIGS. **3**A to **3**D are figures for illustrating a difference in parasitic capacitances, by comparing a case where the metal wiring **107** having varied film thicknesses as shown in FIGS. **1** and **2** is used and a case where a metal wiring **107'** having a uniform thickness (denoted with a prime symbol to be distinguished from the metal wiring **107** of FIGS. **1** and **2**) is used. FIG. **3**A shows the metal wiring **107'** having a uniform thickness and FIG. **3**B shows the metal wiring **107** having varied film thicknesses.

As the metal wiring **107'** of FIG. **3**A has a uniform thickness, a cross section thereof has a square shape. As shown in FIG. **3**A, in cases where the metal wiring **107'** having the square shape is used, a side **107***a'* of the metal wiring **107'** and a side **106***a* of the reflection plate **106** would be sides facing each other and located parallel to each other.

As the metal wiring **107** of FIG. **3**B has varied film thicknesses, a side **107***a* of the metal wiring **107** and the side **106***a* of the reflection plate **106** would be sides facing each other and located parallel to each other. If assumed that a length of the side **107***a'* of the metal wiring **107'** is the same length as the thickness d1, the side **107***a'* would have a length of d1. As a length of the side **107***a* of the metal wiring **107** corresponds to the thickness d2, the side **107***a* would have a length of d2.

As has been described with reference to FIG. **2**, a relationship of d1>d2 is satisfied. Accordingly, the side **107***a'* of the metal wiring **107'** would be longer than the side **107***a* of the metal wiring **107**, and would have a longer part parallel to the side **106***a* of the reflection plate **106**. It is evident that when a space between the sides in such a parallel part is in the same size, the shorter the parallel part is, the smaller the parasitic capacitance may become.

Therefore, in the case where the metal wiring **107** having varied film thicknesses as shown in FIG. **3**B is used, the parasitic capacitance becomes smaller than in the case where the metal wiring **107'** having a uniform thickness as shown in FIG. **3**A is used.

Furthermore, by allowing the parasitic capacitance to be reduced, it makes it possible to dispose the metal wiring **107** close to the reflection plate **106**. FIGS. **3**C and **3**D will be referred. FIG. **3**C shows the metal wiring **107'** shown in FIG. **3**A, and an upper side thereof is a side **107***b'*. FIG. **3**D shows the metal wiring **107** shown in FIG. **3**B; an upper side of the first film thickness part having the film thickness of d1 is a side **107***b*, and an upper side of the second film thickness part having the film thickness of d2 is a side **107***c*.

An upper side (the side closer to the photoelectric conversion part **102**) of the metal wiring **107** has a function of reflecting the light being transmitted through the silicon substrate **101** to the photoelectric conversion part **102**. While the upper side of the metal wiring **107'** is only the side **107***b'*, the upper side of the metal wiring **107** is made up of the side **107***c*+ the side **107***b*+ the side **107***c*.

If assumed that the side **107***b'* and the side **107***b* has the same length, the metal wiring **107** would have an upper side longer by a length of (the side **107***c*)–2 as compared to the upper side of the metal wiring **107'**. This means that the metal wiring **107** has a relatively long part having the function of reflecting the light being transmitted through the silicon substrate **101** to the photoelectric conversion part **102**; which may therefore allow the light transmitted through the silicon substrate **101** to be efficiently reflected to the photoelectric conversion part **102**.

Thus, with the metal wiring **107** having the first film thickness part and the second film thickness part, it makes it possible to enhance the function of reflecting the light being transmitted through the silicon substrate **101** to the photoelectric conversion part **102**.

Hereinafter, the first film thickness part and the second film thickness part will be referred, respectively, to as a "first film thickness part **107***b*" and a "second film thickness part **107***c*" having a film thickness of d2 will be referred to as a "second film thickness part", as appropriate. In the following descriptions as well, a part having a larger film thickness will be denoted by a reference numeral with a letter b, and a part having a smaller film thickness will be denoted by the reference numeral with a letter c.

The shape of the metal wiring **107** that provides the function of efficiently reflecting the light being transmitted through the silicon substrate **101** to the photoelectric conversion part **102** is not limited to the shape as has been illustrated with reference to FIGS. **1**, **2**, **3**A and **3**B. For example, it may be any shape as those shown in FIGS. **4**A and **4**B.

FIG. **4**A will be referred. A cross section of the metal wiring **107** shown in FIG. **4**A has a triangular shape.

In the case of the triangular shape, a vertex part of the metal wiring **107** would be relatively distant from the reflection plate **106**; and a part closer to the base of the triangle would be relatively close to the reflection plate **106**. Since there are no sides parallel to the side of the reflection plate **106** in such a triangular shape, it may make it possible to reduce the parasitic capacitance that appears between the reflection plate **106** and the metal wiring **107**.

In such a manner, the shape of the metal wiring **107** may be a shape with a gradually varied film thickness. The metal wiring **107** shown in FIG. **4**A has a shape in which a center part thereof has the largest film thickness, and the more to the right or the left from the center part, the smaller the film thickness thereof becomes, gradually.

FIG. **4**B will be referred. A cross section of the metal wiring **107** shown in FIG. **4**B has a shape with curved side surfaces. Although not shown in the figure, the shape thereof may also be a trapezoid. In other words, the shape of the metal wiring **107** may have a trapezoidal cross section, and this trapezoidal shape may have its side surfaces curved.

In this case, a part having the same thickness exists at the center part of the cross-sectional shape of the metal wiring **107**, and the more to the right or the left from the center part, the smaller the film thickness thereof becomes, gradually. In such a shape as well, since there are no sides parallel to the side of the reflection plate **106**, it may make it possible to reduce the parasitic capacitance that appears between the reflection plate **106** and the metal wiring **107**.

Furthermore, as shown in FIG. **4**B, by providing the curved surfaces as the sides of the metal wiring **107**, and by providing the curved surfaces with the shape which may allow the light transmitted through the silicon substrate **101** to be efficiently reflected to the photoelectric conversion part **102**, it makes it possible to reflect the light being transmitted through the silicon substrate **101** to the photoelectric conversion part **102** with higher efficiency.

As described above, the shape of the metal wiring **107** may be any shape as long as it has a part having a varied film thickness. Hereinafter, further description will be given, by illustrating the metal wiring **107** having the first film thickness part **107***b* and the second film thickness part **107***c* as has been illustrated with reference to FIGS. **1**, **2**, **3**A and **3**B.

FIG. **5** is a plan view of the reflection portion of the imaging device when the pixel shown in FIG. **1** is viewed from the microlens **104** side (upper side). The reflection portion **115** shown in FIG. **5** has the metal wirings **107** existing around the reflection plate **106**, which are placed in close proximity to the reflection plate **106** so that the space therebetween can inhibit passage of incident light. The reflection portion **115** is formed as an assembly of the reflection plate **106** and the metal wirings **107**.

In other words, the reflection plate **106** and the metal wirings **107** are disposed in such a manner that a region where and the reflection plate **106** the metal wiring **107** are disposed adjacent to each other has a space narrower than a space that can inhibit passage of light having a wavelength detectable by the photoelectric conversion part **102**. The reflection plate and the metal wirings are disposed also in the other embodiments which will be described later.

As has been described with reference to FIG. **2**, the metal wiring **107** is made up of the first film thickness part **107***b* and the second film thickness part **107***c*. The second film thickness part **107***c* is thinner than the first film thickness part **107***b*. For example, the metal wiring **107** may include the first film thickness part **107***b* which has a film thickness of 200 nm, and the second film thickness part **107***c* which has a film thickness of 100 nm.

The film thickness of the second film thickness part **107***c* may be, for example, about 100 nm, from the viewpoint of thin-film limit in which EM (electromigration) resistance can be ensured and aggregation can be prevented in the metal wiring.

Referring to FIG. **5**, a portion of the metal wiring **107** located in a region where two of the metal wirings **107** are disposed adjacent to each other, or in a region where the metal wiring **107** and the reflection plate **106** are disposed adjacent to each other, includes the second film thickness part **107***c*. That is, the metal wirings **107** and the reflection plate **106** are disposed in such a manner that, in the region where two metallic parts are disposed adjacent to each other, at least one of the metallic parts would be the second film thickness part **107***c* having the smaller film thickness. Therefore, as described above, it makes it possible to reduce the parasitic capacitance in the region where the adjacent metallic parts are located.

Thus, according to the imaging device of the first embodiment, the reflection portion **115** is formed as an assembly of the reflection plate **106** and the metal wirings **107**. This may make it possible to make the size of the area of the reflection portion **115** larger and provide the imaging device having high sensitivity.

Further, by providing the metal wiring **107** with a relatively small film thickness (providing the second film thickness part **107***c*) in its part adjacent to the metal wiring **107** of an adjacent pattern thereto, it may prevent an increase in parasitic capacitance. Moreover, the metal wiring **107** is provided with a relatively large film thickness (provided with the first film thickness part **107***b*) in its part other than the part adjacent to the adjacent pattern thereto. This may make it possible to obtain a desired interconnect resistance and form the metal wirings with little signal propagation delay.

[Configuration of Imaging Device of Second Embodiment]

FIGS. **6**A and **6**B show a pixel structure according to a second embodiment. FIG. **6**A is a cross-sectional view of the pixel structure. FIG. **6**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions. It should be noted that in the following descriptions, the components substantially the same as for the first embodiment (FIGS. **1** to **5**) will be denoted by the same reference symbols and the description thereof will be omitted as appropriate.

In the pixel structure shown in FIG. **6**A, some microlenses **104** are formed on an interlayer insulating film **103**, over a silicon substrate **101** in which photoelectric conversion parts **102** are formed. This configuration is substantially the same as the pixel structure of the first embodiment shown in FIG. **1**.

In a surface opposite to a light incidence surface, some reflection portions **201** are formed. Each of the reflection portions **201** is made up of metal wirings **107** and a reflection plate **202**. The metal wirings **107** are used for reading signal charges and applying voltages to each part. This reflection plate **202** has a shape different from that of the reflection plate **106** of the first embodiment.

The metal wirings **107** may be formed separated from the reflection plate **202**, by a space narrow enough so that passage therethrough of incident light would be inhibited. The metal wiring **107** has a relatively small film thickness in its part adjacent to the metal wiring **107** of an adjacent pattern thereto. Furthermore, the reflection plate **202** is provided with a relatively large film thickness in an edge part of its pattern and a relatively small film thickness in its part other than the edge part.

That is, the reflection plate **202** of the second embodiment has a part having a varied film thickness, similarly to the metal wiring **107**. The reflection plate **202** includes a first film thickness part **202***b* having a larger film thickness and a second film thickness part **202***c* having a smaller film thickness. An edge part of the reflection plate **202** would be the first film thickness part **202***b* and a center part of the reflection plate **202** would be the second film thickness part **202***c*.

By thus forming the reflection plate **202** having a recessed shape, it makes it possible to allow the light transmitted through the silicon substrate **101** to be reflected by the reflection plate **202**, and directed to the photoelectric conversion part **102**, as described by the arrows in FIG. **6**A. Accordingly, it makes it possible to reflect the light being transmitted through the silicon substrate **101** to the photoelectric conversion part **102** with higher efficiency.

In the plan view of the reflection portion **201** shown in FIG. **6**B, the metal wirings **107** existing around the reflection plate **202** are placed in close proximity to the reflection plate **202**, so that the space therebetween can inhibit passage of incident light. The reflection portion **201** is formed as an assembly of the reflection plate **202** and the metal wirings **107**.

Similarly to the first embodiment, the metal wiring **107** is made up of the first film thickness part **107***b* and the second film thickness part **107***c*. The second film thickness part **107***c* is thinner than the first film thickness part **107***b*. In a region where two of the metal wirings **107** are disposed adjacent to each other, or in a region where the metal wiring **107** and the reflection plate **202** are disposed adjacent to each other, the second film thickness part **107***c* is located.

That is, the metal wirings **107** and the reflection plate **202** are disposed in such a manner that, in the region where two metallic parts are disposed adjacent to each other, at least one of the metallic parts would be the second film thickness part **107***c* having the smaller film thickness. Therefore, as described above, it makes it possible to reduce the parasitic capacitance in the region where the adjacent metallic parts are located.

In the second embodiment of the present disclosure, by forming the reflection plate **202** having a shape which is recessed with respect to the light incidence surface and has a relatively large thickness in its peripheral part, it makes it possible to allow the light transmitted through the silicon substrate **101** to be reflected by the reflection plate **202**, and directed back toward the center of the photoelectric conversion part. This may make it possible to provide the imaging device having high sensitivity.

[Configuration of Imaging Device of Third Embodiment]

FIGS. **7**A and **7**B show a pixel structure according to a third embodiment. FIG. **7**A is a cross-sectional view of the pixel structure. FIG. **7**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

The third embodiment has substantially the same configuration as the first and second embodiments, except that the shape of the reflection plate is replaced with a different one.

Each reflection portion **251** is made up of metal wirings **107** and a reflection plate **252**. The reflection plate **252** is provided with a relatively large film thickness in an edge part of its pattern and a relatively small film thickness in its part other than the edge part. The reflection plate **252** has a shape similar to that of the metal wiring **107**.

That is, the reflection plate **252** of the third embodiment has a part having a varied film thickness, similarly to the metal wiring **107**. The reflection plate **252** includes a first film thickness part **252***b* having a larger film thickness and a second film thickness part **252***c* having a smaller film thickness. A center part of the reflection plate **252** would be the first film thickness part **252***b* and an edge part of the reflection plate **252** would be the second film thickness part **252***c*.

In the plan view of the reflection portion **251** shown in FIG. **7**B, the metal wirings **107** existing around the reflection plate **252** are placed in close proximity to the reflection plate **252**, so that the space therebetween can inhibit passage of incident light. The reflection portion **251** is formed as an assembly of the reflection plate **252** and the metal wirings **107**.

Similarly to the first embodiment, the metal wiring **107** is made up of the first film thickness part **107***b* and the second film thickness part **107***c*. The second film thickness part **107***c* is thinner than the first film thickness part **107***b*. In a region where two of the metal wirings **107** are disposed adjacent to each other, two of the second film thickness parts **107***c* are located. In a region where the metal wiring **107** and the reflection plate **252** are disposed adjacent to each other, the second film thickness part **107***c* and the second film thickness part **252***c* are located.

That is, the metal wirings **107** and the reflection plate **252** are disposed in such a manner that, in the region where two metallic parts are disposed adjacent to each other, the metallic parts include at least one of the second film thickness part **107***c* and the second film thickness part **252***c*, each having the smaller film thickness. Therefore, as described above, it makes it possible to reduce the parasitic capacitance in the region where the adjacent metallic parts are located. In the third embodiment, since two metallic parts having a relatively small film thickness are disposed adjacent to each other in this region, the parasitic capacitance may be more reduced.

Thus, according to the imaging device of the third embodiment of the present disclosure, by providing the peripheral part of the reflection plate **252** with a relatively small film thickness, it may further reduce the capacitance between the reflection plate **252** and the metal wiring **107** adjacent thereto. This may make it possible to form the metal wirings with little signal propagation delay.

[Configuration of Imaging Device of Fourth Embodiment]

FIGS. **8**A and **8**B show a pixel structure according to a fourth embodiment. FIG. **8**A is a cross-sectional view of the pixel structure. FIG. **8**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

The fourth embodiment has substantially the same configuration as the first to third embodiments, except that the shape of the reflection plate is replaced with a different one.

Each reflection portion **301** is made up of metal wirings **107** and a reflection plate **302**. The reflection plate **302** has substantially the same film thickness over the entire structure thereof. The reflection plate **302** has substantially the same film thickness as that of the second film thickness part **107***c*, which is the smaller film thickness, of the metal wiring **107**. Here, it can be described that the reflection plate **302** includes a second film thickness part **302***c*.

In the plan view of the reflection portion **301** shown in FIG. **8**B, the metal wirings **107** existing around the reflection plate **302** are placed in close proximity to the reflection plate **302**, so that the space therebetween can inhibit passage of incident light. The reflection portion **301** is formed as an assembly of the reflection plate **302** and the metal wirings **107**.

Similarly to the first embodiment, the metal wiring **107** is made up of the first film thickness part **107***b* and the second film thickness part **107***c*. The second film thickness part **107***c* is thinner than the first film thickness part **107***b*. In a region where two of the metal wirings **107** are disposed adjacent to each other, two of the second film thickness parts **107***c* are located. In a region where the metal wiring **107** and the reflection plate **302** are disposed adjacent to each other, the second film thickness part **107***c* and the second film thickness part **302***c* are located.

That is, the metal wirings **107** and the reflection plate **302** are disposed in such a manner that, in the region where two metallic parts are disposed adjacent to each other, the metallic parts include at least one of the second film thickness part **107***c* and the second film thickness part **302***c*, each having the smaller film thickness. Therefore, as described above, it makes it possible to reduce the parasitic capacitance in the region where the adjacent metallic parts are located. In the fourth embodiment, since two metallic parts having a relatively small film thickness are disposed adjacent to each other in this region, the parasitic capacitance may be more reduced.

Thus, according to the imaging device of the fourth embodiment of the present disclosure, by providing the reflection plate **302** with a relatively small film thickness, it may further reduce the capacitance between the reflection plate **302** and the metal wiring **107** adjacent thereto. This may make it possible to form the metal wirings with little signal propagation delay.

Furthermore, in the fourth embodiment, regarding the overall structure of the reflection portion **301** formed by the metal wirings **107** and the reflection plate **302**, a center part of the reflection portion **301** would be a part having the smaller film thickness, which part is formed by the second thickness part **302***c* of the reflection plate **302** and the second thickness parts **107***c* of the metal wirings **107**. An edge part of the reflection portion **301** would be a part having the larger film thickness, which part is formed by the first thickness parts **107***b* of the metal wirings **107**.

That is, the overall structure of the reflection portion **301** includes a center part having the smaller film thickness and an edge part having the larger film thickness. Accordingly, it makes it possible to allow the light transmitted through the silicon substrate **101** to be reflected by the reflection portion **301**, and allow the reflected light to be collected in the center of the photoelectric conversion part **102**, as shown in FIG. **8**A. This may make it possible to provide the imaging device having high sensitivity characteristics.

[Configuration of Imaging Device of Fifth Embodiment]

FIGS. **9**A and **9**B show a pixel structure according to a fifth embodiment. FIG. **9**A is a cross-sectional view of the pixel structure. FIG. **9**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

The fifth embodiment has substantially the same configuration as the first to fourth embodiments, except that the reflection portions are made up of metal wirings.

Referring to FIG. **9**A, each reflection portion **401** is made up of a plurality of metal wirings **402**. In an example shown in FIG. **9**A, the reflection portion **401** includes six metal wirings **402**, which are metal wirings **402-1** to **402-6**. Although the six metal wirings **402** are illustrated here as an example, it is also possible to modify the number of metal wirings **402**.

A shape of each metal wiring **402** is the shape having varied film thicknesses as has been described for the first and other embodiments. A center part of the metal wiring **402** includes a first film thickness part **402***b* having a larger film thickness. An edge part thereof includes a second film thickness part **402***c* having a smaller film thickness.

The metal wirings **402** are formed separated from each other, by a space narrow enough so that passage therethrough of incident light would be inhibited. The metal wiring **402** has a relatively small film thickness in its part adjacent to the metal wiring **402** of an adjacent pattern thereto.

In the plan view of the reflection portion **401** shown in FIG. **9**B, the metal wirings **402** which also function as the reflection portion **401** are placed in close proximity to each other, so that the space therebetween can inhibit passage of incident light. The reflection portion **401** is formed as an assembly of the metal wirings **402**.

Similarly to the first embodiment, the metal wiring **402** is made up of the first film thickness part **402***b* and the second film thickness part **402***c*. The second film thickness part **402***c* is thinner than the first film thickness part **402***b*. In a region where two of the metal wirings **402** are disposed adjacent to each other, two of the second film thickness parts **402***c* are located.

That is, the metal wirings **402** are disposed in such a manner that, in the region where two metallic parts are disposed adjacent to each other, the metallic parts would be the second film thickness parts **402***c* each having the smaller film thickness. Therefore, as described above, it makes it possible to reduce the parasitic capacitance in the region where the adjacent metallic parts are located. In the fifth embodiment, since two metallic parts having a relatively small film thickness are disposed adjacent to each other in this region, the parasitic capacitance may be more reduced.

Thus, according to the imaging device of the fifth embodiment of the present disclosure, the reflection portion **401** can be formed as an assembly of a metal wiring layer, and can reduce the capacitance between adjacent wirings. This may make it possible to form the metal wirings **402** with little signal propagation delay, while achieving an effect of increasing sensitivity by the reflection portion **401**.

Furthermore, since every metal pattern is formed to be used also as a wiring, instead of a reflection plate for the sole purpose of providing a reflecting function, it may have a higher degree of freedom of wiring layout.

Incidentally, in a layout of the reflection portion **401** in the plan view shown in FIG. **9**B, the wirings are arranged along a vertical direction of the figure. However, other layouts are also possible as a matter of course, and the wirings may be laid-out in any direction; for example, a right-and-left direction of the figure.

As shown in FIG. **9**A, the reflection portion **401** has been described as one made up of the metal wirings **402-1** to **402-6**. All of the metal wirings **402-1** to **402-6** may be used as the wirings. Alternatively, a configuration in which some of the metal wirings **402-1** to **402-6** may be used as the wirings and the rest of them may be used as the reflection plate is possible.

[Configuration of Imaging Device of Sixth Embodiment]

FIGS. **10**A and **10**B show a pixel structure according to a sixth embodiment. FIG. **10**A is a cross-sectional view of the pixel structure. FIG. **10**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

The sixth embodiment has substantially the same configuration as the first to fourth embodiments, except that the reflection portions are made up of metal wirings.

Referring to FIG. **10**A, each reflection portion **451** is made up of metal wirings **452** and metal wirings **453**. As shown in FIG. **10**A, four metal wirings **452** are located at a center of the corresponding reflection portion **451**, and the metal wirings **453** are located at right and left ends of the reflection portion **451**. In the example shown in FIG. **10**A, the reflection portion **451** includes six metal wirings.

A shape of each metal wiring **453** located at the end of the reflection portion **451** is the shape having varied film thicknesses as has been described for the first and other embodiments. A center part of the metal wiring **453** includes a first film thickness part **453***b* having a larger film thickness. An edge part thereof includes a second film thickness part **453***c* having a smaller film thickness.

A shape of each metal wiring **452** located at a center of the reflection portion **451** has a substantially uniform film thickness, which is substantially the same film thickness as that of the second film thickness part **453***c* of the metal wiring **453**. The metal wirings **452** and **453** which make up the reflection portion **451** are formed separated from each other, by a space narrow enough so that passage therethrough of incident light would be inhibited. The metal wirings **452** and **453** have a relatively small film thickness in their part adjacent to any of the metal wirings **452** and **453** of an adjacent pattern thereto.

In the plan view of the reflection portion **451** shown in FIG. **10**B, the metal wirings **452** and **453** which also function as the reflection portion **451** are placed in close proximity to each other, so that the space therebetween can inhibit passage of incident light. The reflection portion **451** is formed as an assembly of the metal wirings **452** and **453**.

The metal wirings **452** and **453** are disposed in such a manner that, in the region of the reflection portion **451** where two metallic parts are disposed adjacent to each other, the metallic parts include at least one of a second film thickness part **452***c* of the metal wiring **452** and the second film thickness part **453***c* of the metal wiring **453**, each having the smaller film thickness. Therefore, as described above, it makes it possible to reduce the parasitic capacitance in the region where the adjacent metallic parts are located. In the sixth embodiment, since two metallic parts having a relatively small film thickness are disposed adjacent to each other in this region, the parasitic capacitance may be more reduced.

Thus, according to the sixth embodiment of the present disclosure, the reflection portion **451** can be formed as an assembly of a metal wiring layer, and can reduce the capacitance between adjacent wirings. This may make it possible to form the metal wirings **452** and **453** with little signal propagation delay, while achieving an effect of increasing sensitivity by the reflection portion **451**.

Furthermore, since every metal pattern is formed to be used also as a wiring, instead of a reflection plate for the sole purpose of providing a reflecting function, it may have a higher degree of freedom of wiring layout.

Moreover, in the sixth embodiment, regarding the overall structure of the reflection portion **451** formed by the metal wirings **452** and **453**, a center part of the reflection portion **451** would be a part having the smaller film thickness, which part is formed by the second thickness parts **452***c* of the metal wirings **452** and the second thickness parts **453***c* of the metal wirings **453**. An edge part of the reflection portion **451** would be a part having the larger film thickness, which part is formed by the first thickness parts **453***b* of the metal wirings **453**.

That is, the overall structure of the reflection portion **451** includes a center part having the smaller film thickness and an edge part having the larger film thickness. Accordingly, it makes it possible to allow the light transmitted through the silicon substrate **101** to be reflected by the reflection portion **451**, and allow the reflected light to be collected in the center of the photoelectric conversion part **102**, as shown in FIG. **10**A. This may make it possible to provide the imaging device having high sensitivity characteristics.

[Configuration of Imaging Device of Seventh Embodiment]

FIGS. **11**A and **11**B show a pixel structure according to a seventh embodiment. FIG. **11**A is a cross-sectional view of the pixel structure. FIG. **11**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

The seventh embodiment has substantially the same configuration as the first to sixth embodiments, except that the configuration of the photoelectric conversion parts is replaced with a different one.

Each photoelectric conversion part in the pixel structure shown in FIG. **11**A includes a first photoelectric conversion part **501**, a second photoelectric conversion part **502** and a third photoelectric conversion part **503** being laminated in a single pixel region. Some microlenses **104** are formed on an interlayer insulating film **103**, over a silicon substrate **101** in which the photoelectric conversion parts having these three layers of photoelectric conversion parts are formed.

Further, in a surface opposite to a light incidence surface, some reflection portions **115** are formed. Each of the reflection portions **115** is made up of metal wirings **107** and a reflection plate **106**. The metal wirings **107** are used for reading signal charges and applying voltages to each part. Since this configuration is substantially the same as in the first embodiment, the description thereof will be omitted. FIG. **11**B is a plan view of the reflection portions of the imaging device according to the seventh embodiment. Since this figure is substantially the same as that for the first embodiment, the description thereof will be omitted.

Here, the configuration of the reflection portions **115** is illustrated by an example employing the configuration that has been described as the first embodiment. Any of the second to sixth embodiments may be employed as well. In other words, an embodiment may have a configuration in which the configuration of the first photoelectric conversion part **501**, the second photoelectric conversion part **502** and the third photoelectric conversion part **503** being laminated in a single pixel region is combined with a configuration of the reflection portions according to any of the first to sixth embodiments.

In the imaging device according to the seventh embodiment, the photoelectric conversion part has a laminated structure of the first photoelectric conversion part **501**, the second photoelectric conversion part **502** and the third photoelectric conversion part **503**, and these photoelectric conversion parts may produce an output by photoelectrically converting light having a wavelength of a corresponding wavelength region assigned to each of the photoelectric conversion parts.

The deeper the position of the photoelectric conversion part is as seen from the light incidence surface, the longer-wavelength region the wavelength region detectable by the photoelectric conversion part may become. Accordingly, the light that does not undergo photoelectric conversion by the third photoelectric conversion part **503** for detecting the longest wavelength light may be reflected by the reflection portion **115**, to enter the third photoelectric conversion part **503** again.

The reflection of light by the reflection portion **115** may be effective especially for long-wavelength light.

By applying this feature to the imaging device having a laminated photoelectric conversion part as shown in FIG. **11**A, it may allow enhancement of the sensitivity characteristics of the photoelectric conversion part, especially, of one formed at the deepest position in the substrate.

In a region where the reflection plate **106** and the metal wiring **107** are disposed adjacent to each other, and in a region where two of the metal wirings **107** are disposed adjacent to each other, a space separating the metal wiring **107** from the reflection plate **106** or another metal wiring **107** is set narrower than a space that can inhibit passage of light having a wavelength detectable by the photoelectric conversion part that is closest to the reflection portion **115** (shown as the third photoelectric conversion part **503** in FIG. **11**A) among the plurality of photoelectric conversion parts being laminated. Such a narrow space may make it possible to allow the light transmitted through the silicon substrate **101** to be reflected by the reflection portion **115** with little loss.

Thus, the present disclosure may also be applied to imaging devices having a laminated photoelectric conversion part. This may allow enhancement of the sensitivity characteristics of the imaging device having the laminated photoelectric conversion part.

Incidentally, this embodiment has been illustrated by an example employing the structure in which three layers of photoelectric conversion parts are laminated. However, the number of the laminated layers of the photoelectric conversion part is not limited to three.

[Configuration of Imaging Device of Eighth Embodiment]

In one imaging device, any of the reflection portions described in the first to sixth embodiments may be used in combination. For example, it is also possible to employ reflection portions each having a different structure depending on their position in an image region.

FIG. **12** is a plan view showing a chip layout of an imaging device having reflection portions according to an eighth embodiment. In the chip layout shown in FIG. **12**, an image region **602** is arranged in an imaging device **601**.

In the image region **602**, pixels are arranged in a matrix.

Among the pixels arranged in the image region **602**, center pixels **603** located at the center of the image region **602**, right end pixels **604** located at the right end of the image region **602**, and left end pixels **605** located at the left end of the image region **602** are each provided with reflection portions having a corresponding configuration with a different structure depending on the position. Regarding these pixels, mainly, the configuration of the reflection portions will be described with reference to FIGS. **13**A to **15**B.

FIGS. **13**A and **13**B show a pixel structure of the center pixels **603** of the eighth embodiment. FIG. **13**A is a cross-sectional view of the pixel structure. FIG. **13**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

The reflection portions **301** shown in FIGS. **13**A and **13**B have substantially the same configuration as the reflection portions **301** that have been shown in FIGS. **8**A and **8**B for the fourth embodiment. That is, the reflection portion **301** is made up of the reflection plate **302** and the metal wirings **107**. The reflection plate **302** has substantially the same film thickness as that of an edge part of the metal wiring **107**, which is the smaller film thickness. A shape of the metal wiring **107** is the shape having the first film thickness part **107***b* and the second film thickness part **107***c*.

Since the reflection portions **301** formed in such a shape have already been described with reference to FIGS. **8**A and **8**B, a description thereof in detail will be omitted. As shown in FIG. **13**A, the reflection portions **301** located at the center pixels **603** may have a configuration suitable for efficiently reflecting the light being incident vertically on an imaging surface to the photoelectric conversion part **102**.

Although a case of employing the reflection portions **301** that have been described for the fourth embodiment is illustrated here as an example, it is also possible to employ the reflection portions of the other embodiments.

FIGS. **14**A and **14**B show a pixel structure of the right end pixels **604** of the eighth embodiment. FIG. **14**A is a cross-sectional view of the pixel structure. FIG. **14**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

In the pixel structure shown in FIGS. **14**A and **14**B, each reflection portion **651** is made up of the reflection plate **302** and metal wirings **652**. Similarly to the reflection plate **302** of the center pixel **603** shown in FIGS. **13**A and **13**B, the reflection plate **302** is made up of the second film thickness part **302***c* having the smaller film thickness.

A shape of the metal wiring **652** is the shape having varied film thicknesses, similarly to the metal wiring **107** of the center pixel **603** shown in FIGS. **13**A and **13**B. However, the shape of the metal wiring **652** has its one edge at the left side in the figure formed by a second film thickness part **652***c* having the smaller film thickness; which is different from the metal wiring **107** that has its both edge parts each formed by the second film thickness part **107***c* having the smaller film thickness.

The metal wiring **652** of the right end pixel **604** shown in FIG. **14**A has a right part in the figure formed by a first film thickness part **652***b* having the larger film thickness; and a left part in the figure formed by the second film thickness part **652***c* having the smaller film thickness.

As shown in FIG. **14**A, the reflection portions **651** located at the right end pixels **604** may have a configuration suitable for efficiently reflecting the light being incident from a left oblique direction on the right end pixels **604** to the photoelectric conversion part **102**.

When the reflection portions **651** are configured in such a manner, since the reflection plates **302** are made up of the second film thickness parts **302***c* having the smaller film thickness, a part thereof which is adjacent to the metal wiring **652** would be an adjacent second film thickness part **302***c* thereto. As a result, similarly to the above-mentioned embodiments, it may make it possible to reduce the capacitance between the metal wiring **652** and the reflection plate **302** which are adjacent to each other.

Further, in the region where two metal wirings **652** are disposed adjacent to each other, the first film thickness part **652***b* and the second film thickness part **652***c* would be adjacent to each other. This may make it possible to reduce the capacitance between the metal wirings **652** which are adjacent to each other.

FIGS. **15**A and **15**B show a pixel structure of the left end pixels **605** of the eighth embodiment. FIG. **15**A is a cross-sectional view of the pixel structure. FIG. **15**B is a plan view of the pixel structure as viewed from the upper side, and mainly shows a configuration of reflection portions.

In the pixel structure shown in FIGS. **15**A and **15**B, each reflection portion **701** is made up of the reflection plate **302** and metal wirings **702**. Similarly to the reflection plate **302** of the center pixel **603** shown in FIGS. **13**A and **13**B, the reflection plate **302** is made up of the second film thickness part **302***c* having the smaller film thickness.

A shape of the metal wiring **702** is the shape having varied film thicknesses, similarly to the metal wiring **107** of the center pixel **603** shown in FIGS. **13**A and **13**B. However, the shape of the metal wiring **702** has its one edge at the right side in the figure formed by a second film thickness part **702***c* having the smaller film thickness; which is different from the metal wiring **107** that has its both edge parts each formed by the second film thickness part **107***c* having the smaller film thickness.

The metal wiring **702** of the left end pixel **605** shown in FIG. **15**A has a left part in the figure formed by a first film thickness part **702***b* having the larger film thickness; and a right part in the figure formed by the second film thickness part **702***c* having the smaller film thickness.

As shown in FIG. **15**A, the reflection portions **701** located at the left end pixels **605** may have a configuration suitable for efficiently reflecting the light being incident from a right oblique direction on the left end pixels **605** to the photoelectric conversion part **102**.

When the reflection portions **701** are configured in such a manner, since the reflection plates **302** are made up of the second film thickness parts **302***c* having the smaller film thickness, a part thereof which is adjacent to the metal wiring **702** would be an adjacent second film thickness part **302***c* thereto. As a result, similarly to the above-mentioned embodiments, it may make it possible to reduce the capacitance between the metal wiring **702** and the reflection plate **302** which are adjacent to each other.

Further, in the region where two metal wirings **702** are disposed adjacent to each other, the first film thickness part **702***b* and the second film thickness part **702***c* would be adjacent to each other. This may make it possible to reduce the capacitance between the metal wirings **702** which are adjacent to each other.

The imaging device according to the eighth embodiment of the present disclosure may allow the reflected light to be collected in different directions by allowing the metal wirings that make up the reflection portions to have a different shape depending on the position of corresponding pixels in the image region **602**.

This, for example, makes it possible to correct a reflection direction of the reflected light to be directed toward the center of the photoelectric conversion part **102**, even in cases where the incidence angle of the light is different depending on the position of the pixel in the image region **602**.

[Process of Production of Imaging Device]

Next, a process of production of the imaging devices of the first to eighth embodiments will be described. Here, a description will be given by illustrating a process of production of the imaging device of the first embodiment. The imaging devices of the second to eighth embodiments are also able to be produced by basically similar processes to that for the first embodiment, and the description thereof will be omitted.

FIGS. **16** to **19** are figures for illustrating a process of the production of the imaging device of the first embodiment. The figures are cross-sectional diagrams of the process of producing an imaging device performed in sequence.

As shown in FIG. **16**, in the step S**1**, the photoelectric conversion parts **102** are formed in the silicon substrate **101**. Although not shown in FIG. **16**, the step S**1** may also include forming, in addition to the photoelectric conversion parts **102**, other parts such as element isolating regions for electrically isolating each of the photoelectric conversion parts **102**, transistors configuring a read circuit for reading signal charges, and diffusion layer for storing signal charges.

Incidentally, in a case where the imaging device having the first to third photoelectric conversion parts **501** to **503** being laminated as shown in FIGS. **11**A and **11**B is to be produced, each of the first to third photoelectric conversion parts **501** to **503** may be formed in the silicon substrate **101** in the step S**1**.

In the step S**2**, the insulating film **105** is formed on the silicon substrate **101**. After the formation of the insulating film **105**, in the step S**3**, first wiring recesses **801** are formed to the insulating film **105**. The first wiring recess **801** is a recess which is for forming the first film thickness part **107***b* of the metal wiring **107**. In addition, in the step S**3**, other recesses which are for forming the reflection plates **106** are also formed.

Next, in the step S**4**, in an entire surface of the device, a layer of planarization material **802** is formed to fill the first wiring recesses **801** and to planarize the surface. On the planarized layer of the planarization material **802**, photoresists **803** are formed. The photoresists **803** are formed in regions other than regions where the second film-thickness parts of the metal wirings **107** are intended to be formed.

Then, in the step S**5** shown in FIG. **17**, by an etching process performed using the photoresists **803** as a mask, the planarization material **802** and the insulating film **105** in predetermined regions are removed, to form second wiring recesses **804**. The second wiring recess **804** is a recess which is for forming the second film thickness part **107***c* of the metal wiring **107**.

In the step S**6**, the photoresists **803** and the planarization material **802** are removed, to form wiring recesses **805** each having varied depths and reflection-plate recesses **806** each having a uniform depth. The wiring recess **805** is a recess in which the metal wiring **107** is to be formed. The reflection-plate recess **806** is a recess in which the reflection plate **106** is to be formed.

In the step S**7**, in an entire surface of the device, a metallic material film **807** is formed. In such a manner, the reflection portions **115** may be each formed as a metallic material film by damascene method.

For example, the metallic material film **807** may be copper deposited by plating. Before depositing the copper by plating, a tantalum film which serves as a barrier metal; and copper which serves as a seed film for plating may be deposited by sputtering in advance (not shown). Thus, examples of the metallic material film **807** include copper and a copper alloy.

In the step S**8**, chemical mechanical polishing (CMP method) may be performed, to remove the metallic material film **807** except that formed in the wiring recesses **805** and the reflection-plate recesses **806** and form the reflection plates **106** and the metal wirings **107**.

The reflection plates **106** and the metal wirings **107** are thus formed. In cases where the reflection plates and the metal wirings of any of the second to eighth embodiments are to be produced, the first wiring recesses **801** and the second wiring recesses **804** having the shapes matching to the shapes of the reflection plates and the metal wirings may be formed.

In the step S**9** shown in FIG. **18**, in an entire surface of the device, an insulating film **808** is formed. The reflection plates **106** and the metal wirings **107** would be enclosed by the insulating film **105** having already been formed and the insulating film **808** being formed in this step.

In the step S**10**, the substrate is inverted; and a support substrate **809** is stuck to the surface of the device on the side at which the reflection plates **106** and the metal wirings **107** have been formed. Subsequently, in the step S**11**, the silicon substrate **101** is thinned, so that the position of the photoelectric conversion parts **102** would be in the vicinity of a surface of the silicon substrate.

In the step S**12** shown in FIG. **19**, the interlayer insulating film **103** and the microlenses **104** are formed. Then, in the step S**13**, the support substrate **809** is removed; for example, by grinding.

Thus, the imaging device according to the embodiment would be produced.

By such a production method, it makes it possible to form the imaging device having the reflection portion **115** formed as an assembly of the reflection plate **106** and the metal wirings **107**, with each of the metal wirings **107** having the first film thickness part **107***b* and the second film thickness part **107***c*.

In the production method of this embodiment, the formation of the wiring recesses for forming the metal wirings **107** having varied film thicknesses, the second wiring recesses **804** have been patterned after the formation of the first wiring recesses **801** in such a manner that the second wiring recesses **804** would cover the regions of the first wiring recesses **801**, which first wiring recesses **801** correspond to parts having the larger film thickness. However, instead of this, it is also possible to first form the second wiring recesses **804**, and then form the first wiring recesses **801** within predetermined regions of the second wiring recesses **804**, to form the metal wirings **107** having varied film thicknesses.

It should be noted that although the metallic material film that makes up the reflection portion has been illustrated in the figures as a single layer of metallic material, each of the above-mentioned embodiments may also be applied to any one of a plurality of metallic material layers in a case where the reflection portion includes a plurality of metal wiring layers. In other words, in cases where a plurality of metal wiring layers is to be provided in the reflection portions, it is also possible to form the reflection portions with a metallic material film made of the same material as at least one metal wiring layer among the metal wiring layers.

[Electronic Apparatus]

The present disclosure is not limited to the application to an imaging device. The present disclosure may also be applied to imaging apparatuses such as digital still cameras and video cameras; portable terminal apparatuses such as mobile phones which have an imaging function; copying machines which use an imaging device as an image-reading part, and other electronic apparatuses in general which use an imaging device as an image-capturing part (photoelectric conversion part). Incidentally, a modular form which can be installed in an electronic apparatus, that is, a camera module, may also be an example of such an imaging device or imaging apparatus.

FIG. **20** is a block diagram illustrating an imaging apparatus as an electronic apparatus of one embodiment of the present disclosure. As shown in FIG. **20**, the imaging apparatus **1000** of this embodiment includes an optical system including a lens group **1001** and the like; an imaging element **1002**; a DSP (digital signal processing) circuit **1003** which is a camera signal processing unit; a frame memory **1004**; a display apparatus **1005**; a recording apparatus **1006**; an operation system **1007**; a power source system **1008**, and the like.

Further, the DSP circuit **1003**, the frame memory **1004**, the display apparatus **1005**, the recording apparatus **1006**, the operation system **1007** and the power source system **1008** are mutually connected via a bus line **1009**. A CPU (central processing unit) **1010** is configured to control each part of the imaging apparatus **1000**.

The lens group **1001** takes in incident light (image light) from an object and forms an image on an imaging surface of the imaging element **1002**. The imaging element **1002** converts an amount of incident light imaged on the imaging surface by the lens group **1001** into an electrical signal per pixel and outputs the signal as a pixel signal.

As this imaging element **1002**, for example, a solid-state imaging element configured as an imaging device according to any of the embodiments described above may be used.

The display apparatus **1005** may be made of a panel-type display apparatus such as a liquid crystal display apparatus and an organic EL (electro-luminescence) display apparatus. The display apparatus **1005** is configured to display a video image or a still image taken by the imaging element **1002**. The recording apparatus **1006** is configured to record the video image or the still image taken by the imaging element **1002** in a recording medium such as a video tape and a DVD (Digital Versatile Disc).

The operation system **1007** is configured to issue operation commands for various functions provided to this imaging apparatus **1000** based on a user operation. The power source system **1008** is configured to variously supply power as an operation power to the DSP circuit **1003**, the frame memory **1004**, the display apparatus **1005**, the recording apparatus **1006**, and the operation system **1007**, as appropriate.

Such an imaging apparatus **1000** may be applied to video cameras, digital still cameras and camera modules for mobile equipment such as mobile phones. Furthermore, in such an imaging apparatus **1000**, the above-mentioned imaging device according to any of the embodiments may be used as the imaging element **1002**.

As used herein, the term "system" represents a whole apparatus including a plurality of devices or apparatuses.

It should be noted that the effects described herein are non-limitative examples. Some embodiments of the present disclosure may also have additional effects.

In addition, the present disclosure is not limited to each of the above-mentioned embodiments and can be variously modified without departing from the gist of the present disclosure.

The present disclosure may employ the following configurations.

(1) A solid-state imaging device, including:

a semiconductor substrate including a light receiving surface;

a plurality of photoelectric conversion parts provided within the semiconductor substrate; and

a plurality of reflection portions provided in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface;

where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

(2) The imaging device according to (1), where the reflection plate and each of the plurality of metal wirings do not overlap in a depth direction of the semiconductor substrate.

(3) The imaging device according to (1), where the reflection plate is a secondary set of metal wirings.

(4) The imaging device according to (1), where at least one of the plurality of metal wirings includes a portion having a first film thickness and a portion having a second film thickness that is smaller than the first film thickness.

(5) The imaging device according to (4), where the reflection plate is one of the first film thickness and the second film thickness.

(6) The imaging device according to (4), where at least one of the plurality of metal wirings has a center part having the first film thickness and edge parts having the second film thickness, the center part being between the edge parts.

(7) The imaging device according to (6), where the reflection plate has a center part having one of the first film thickness and the second film thickness, and the reflection plate has edge parts having the other one of the first film thickness and the second film thickness, the center part of the reflection plate being between the edge parts of the reflection plate.

(8) The imaging device according to (6), where each metal wiring that is adjacent to the reflection plate is separated from the reflection plate by a space having a width that inhibits passage of the incident light through the space.

(9) The imaging device according to (8), where the width of the space is approximately 0.25 micrometers or less.

(10) The imaging device according to (3), where each metal wiring in the plurality of metal wirings has a same size and a same shape, and where each metal wiring in the secondary set of metal wirings has the same shape and the same size.

(11) The imaging device according to (1), where a cross section of at least one of the plurality of metal wirings has a triangular shape.

(12) The imaging device according to (1), where a cross section of at least one of the plurality of metal wirings has a trapezoid shape.

(13) The imaging device according to (12), where the trapezoid shape has curved side surfaces.

(14) A method of manufacturing an imaging device, the method including:

providing a semiconductor substrate having a light receiving surface and a plurality of photoelectric conversion parts within the semiconductor substrate; and

providing a plurality of reflection portions in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface;

where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

(15) The method of manufacturing an imaging device according to (14), where the reflection plate and each of the plurality of metal wirings do not overlap in a depth direction of the semiconductor substrate.

(16) The method of manufacturing an imaging device according to (14), where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where at least one of the plurality of metal wirings has a center part having a first film thickness and edge parts having a second film thickness that is smaller than the first film thickness, the center part being between the edge parts.

(17) The method of manufacturing an imaging device according to (16), where the reflection plate has a center part having one of the first film thickness and the second film thickness, and the reflection plate has edge parts having the other one of the first film thickness and the second film thickness, the center part of the reflection plate being between the edge parts of the reflection plate.

(18) An electronic apparatus including:

an imaging device including:

a semiconductor substrate including a light receiving surface;

a plurality of photoelectric conversion parts provided within the semiconductor substrate; and

a plurality of reflection portions provided in the semiconductor substrate on a side of the photoelectric conversion parts that is opposite from the light receiving surface;

where each of the reflection portions includes a reflection plate and a plurality of metal wirings, and where the plurality of metal wirings are disposed in a same layer of the semiconductor substrate as the reflection plate.

(19) The electronic apparatus according to (18), where the electronic apparatus further includes a signal processing unit, the signal processing unit configured to perform signal processing on an image signal output from the solid-state imaging device.

(20) The electronic apparatus according to (18), where the reflection plate and each of the plurality of metal wirings do not overlap in a depth direction of the semiconductor substrate.

(21) An imaging device including:

- a semiconductor substrate having
  - a light incidence surface,
  - a semiconductor substrate surface opposite to the light incidence surface and
  - a plurality of photoelectric conversion parts;
- and
- a plurality of reflection portions provided in the semiconductor substrate surface opposite to the light incidence surface, each of the reflection portions being configured to reflect incident light to a corresponding one of the photoelectric conversion parts, each of the reflection portions including a reflection plate and a plurality of metal wirings,
  - at least one of the metal wirings including a part having a first film thickness and a part having a second film thickness smaller than the first film thickness.

(22) The imaging device according to (21), in which

- the plurality of reflection portions has at least a region where two of the metal wirings are disposed adjacent to each other, in which region, the part having the second film thickness of at least one of the two of the metal wirings is located.

(23) The imaging device according to (21) or (22), in which

- the reflection plate has substantially the same film thickness as the first thickness, and
- each of the reflection portions has at least a region where one of the metal wirings and the reflection plate are disposed adjacent to each other, in which region, the part having the second film thickness of the one of the metal wirings is located.

(24) The imaging device according to (21) or (22), in which

- the reflection plate has
  - at least one edge part having substantially the same film thickness as the first thickness and

a center part having substantially the same film thickness as the second thickness, and

each of the reflection portions has at least a region where one of the metal wirings and the reflection plate are disposed adjacent to each other, in which region, the part having the second film thickness of the one of the metal wirings and the part of the reflection plate having substantially the first film thickness are located.

(25) The imaging device according to (21) or (22), in which

the reflection plate has

a center part having substantially the same film thickness as the first thickness and

at least one edge part having substantially the same film thickness as the second thickness, and

each of the reflection portions has at least a region where one of the metal wirings and the reflection plate are disposed adjacent to each other, in which region, the part having the second film thickness of the one of the metal wirings and the part of the reflection plate having substantially the second film thickness are located.

(26) The imaging device according to (21) or (22), in which

the reflection plate has substantially the same film thickness as the second thickness, and

each of the reflection portions has at least a region where one of the metal wirings and the reflection plate are disposed adjacent to each other, in which region, the part having the second film thickness of the one of the metal wirings is located.

(27) The imaging device according to (21) or (22), in which

the reflection plate is configured to also function as one of the metal wirings, and

each of the metal wirings includes a part having the first film thickness and a part having the second film thickness.

(28) The imaging device according to (27), in which

the metal wirings are disposed adjacent to each other by their parts having the second film thickness.

(29) The imaging device according to (21) or (22), in which

the reflection plate is configured to also function as one of the metal wirings, and

each of the reflection portions includes

at least one first metal wiring having a part having the first film thickness and a part having the second film thickness and

at least one second metal wiring having the second film thickness.

(30) The imaging device according to (29), in which

the first metal wiring is located at an end of each of the reflection portions and

the second metal wiring is located at a center of each of the reflection portions.

(31) The imaging device according to (22), in which

the metal wirings disposed adjacent to each other are separated by a space narrower than a space that can inhibit passage of light having a wavelength detectable by the photoelectric conversion parts.

(32) The imaging device according to any one of (21) to (31), in which

the plurality of photoelectric conversion parts includes a plurality of photoelectric conversion parts being laminated in a single pixel region.

(33) The imaging device according to (32), in which

two of the metal wirings are disposed adjacent to each other, the two of the metal wirings being separated by a space narrower than a space that can inhibit passage of light having a wavelength detectable by a photoelectric conversion part that is close to a reflection portion, among the plurality of photoelectric conversion parts being laminated.

(34) The imaging device according to any one of (21) to (33), in which

each of the reflection portions has a different structure depending on a position in an image region where the photoelectric conversion parts are arranged in a matrix.

(35) The imaging device according to (34), in which

at least one of the metal wirings of at least one of the reflection portions located at a center of the image region includes a center part having the first film thickness and both edge parts having the second film thickness,

at least one of the metal wirings of at least one of the reflection portions located at a right end of the image region includes a right part having the first film thickness and a left part having the second film thickness, and

at least one of the metal wirings of at least one of the reflection portions located at a left end of the image region includes a left part having the first film thickness and a right part having the second film thickness.

(36) An apparatus for production of an imaging device, which is

configured to produce an imaging device, the imaging device including

a semiconductor substrate having

a light incidence surface,

a semiconductor substrate surface opposite to the light incidence surface and

a plurality of photoelectric conversion parts; and

a plurality of reflection portions provided in the semiconductor substrate surface opposite to the light incidence surface, each of the reflection portions being configured to reflect incident light to a corresponding one of the photoelectric conversion parts, each of the reflection portions including a reflection plate and a plurality of metal wirings,

at least one of the metal wirings including a part having a first film thickness and a part having a second film thickness smaller than the first film thickness.

(37) The apparatus for production according to (36), which is

configured to form the reflection portions by

forming an insulating film on the semiconductor substrate,

forming a first recessed portion to the insulating film,

forming a second recessed portion within a predetermined region of the first recessed portion,

forming a metallic material film in the first and second recessed portions, and

polishing the metallic material film, to remove the metallic material film except that formed in the first and second recessed portions.

(38) The apparatus for production according to (36), which is

configured to form the reflection portions by

forming an insulating film on the semiconductor substrate,

forming a first recessed portion to the insulating film,
forming a second recessed portion containing a region of the first recessed portion,
forming a metallic material film in the first and second recessed portions, and
polishing the metallic material film, to remove the metallic material film except that formed in the first and second recessed portions.

(39) A method for producing an imaging device, the method including:

providing a semiconductor substrate having
a light incidence surface,
a semiconductor substrate surface opposite to the light incidence surface and
a plurality of photoelectric conversion parts; and
providing a plurality of reflection portions in the semiconductor substrate surface opposite to the light incidence surface, each of the reflection portions being configured to reflect incident light to a corresponding one of the photoelectric conversion parts, each of the reflection portions including a reflection plate and a plurality of metal wirings,
at least one of the metal wirings including a part having a first film thickness and a part having a second film thickness smaller than the first film thickness, to produce the imaging device.

(40) An electronic apparatus including:

an imaging device including
a semiconductor substrate having
a light incidence surface,
a semiconductor substrate surface opposite to the light incidence surface and
a plurality of photoelectric conversion parts, and
a plurality of reflection portions provided in the semiconductor substrate surface opposite to the light incidence surface, each of the reflection portions being configured to reflect incident light to a corresponding one of the photoelectric conversion parts, each of the reflection portions including a reflection plate and a plurality of metal wirings,
at least one of the metal wirings including a part having a first film thickness and a part having a second film thickness smaller than the first film thickness; and
a signal processing unit configured to perform signal processing on an image signal output from the imaging device.

It should be understood by those skilled in the art that various modifications, combinations, sub-combinations and alterations may occur depending on design requirements and other factors insofar as they are within the scope of the appended claims or the equivalents thereof.

What is claimed is:

1. A solid-state imaging device, comprising:
a semiconductor substrate including a light receiving surface;
a plurality of photoelectric conversion parts provided within the semiconductor substrate; and
a plurality of reflection portions provided on a side of the photoelectric conversion parts that is opposite from the light receiving surface;
wherein each of the reflection portions includes a reflection plate and a plurality of metal wirings,
wherein the plurality of metal wirings are disposed in a same layer as the reflection plate,
wherein for at least one of the reflection portions, the reflection plate and the metal wirings of the at least one reflection portion are each in contact with only a same material in a cross-sectional view of the solid-state imaging device,
wherein the same material is in direct contact with the semiconductor substrate having the plurality of photoelectric conversion parts provided within,
wherein the reflection plate does not overlap with each of the plurality of metal wirings and each of the plurality of metal wirings do not overlap with one another in a depth direction of the solid-state imaging device, and
wherein at least one side of each of the metal wirings and the reflection plate are each disposed at a same distance, when measured in a same direction, from an edge of the semiconductor substrate.

2. The imaging device according to claim **1**, wherein the reflection plate is a secondary set of metal wirings.

3. The imaging device according to claim **2**, wherein each metal wiring in the plurality of metal wirings has a same size and a same shape, and wherein each metal wiring in the secondary set of metal wirings has the same shape and the same size.

4. The imaging device according to claim **1**, wherein at least one of the plurality of metal wirings includes a portion having a first film thickness and a portion having a second film thickness that is smaller than the first film thickness.

5. The imaging device according to claim **4**, wherein the reflection plate is one of the first film thickness and the second film thickness.

6. The imaging device according to claim **4**, wherein at least one of the plurality of metal wirings has a center part having the first film thickness and edge parts having the second film thickness, the center part being between the edge parts.

7. The imaging device according to claim **6**, wherein the reflection plate has a center part having one of the first film thickness and the second film thickness, and the reflection plate has edge parts having the other one of the first film thickness and the second film thickness, the center part of the reflection plate being between the edge parts of the reflection plate.

8. The imaging device according to claim **6**, wherein each metal wiring that is adjacent to the reflection plate is separated from the reflection plate by a space having a width that inhibits passage of the incident light through the space, and wherein the width of the space is approximately 0.25 micrometers or less.

9. The imaging device according to claim **1**, wherein a cross section of at least one of the plurality of metal wirings has a triangular shape.

10. The imaging device according to claim **1**, wherein a cross section of at least one of the plurality of metal wirings has a trapezoid shape.

11. The imaging device according to claim **10**, wherein the trapezoid shape has curved side surfaces.

12. The imaging device according to claim **1**, wherein the same material is an insulating film.

13. The imaging device according to claim **12**, wherein the insulating film is in direct contact with a side of the semiconductor substrate that extends continuously from under a first photoelectric conversion part to under a second photoelectric conversion part, when measured in the same direction, and wherein the plurality of photoelectric conversion parts comprise the first photoelectric conversion part and the second photoelectric conversion part.

14. A method of manufacturing a solid-state imaging device, the method comprising:

providing a semiconductor substrate having a light receiving surface and a plurality of photoelectric conversion parts within the semiconductor substrate; and

providing a plurality of reflection portions on a side of the photoelectric conversion parts that is opposite from the light receiving surface;

wherein each of the reflection portions includes a reflection plate and a plurality of metal wirings,

wherein the plurality of metal wirings are disposed in a same layer as the reflection plate,

wherein for at least one of the reflection portions, the reflection plate and the metal wirings of the at least one reflection portion are each in contact with only a same material in a cross-sectional view of the solid-state imaging device,

wherein the same material is in direct contact with the semiconductor substrate having the plurality of photoelectric conversion parts provided within,

wherein the reflection plate does not overlap with each of the plurality of metal wirings and each of the plurality of metal wirings do not overlap with one another in a depth direction of the solid-state imaging device, and

wherein at least one side of each of the metal wirings and the reflection plate are each disposed at a same distance, when measured in a same direction, from an edge of the semiconductor substrate.

15. The method of manufacturing an imaging device according to claim **14**, wherein sides of the metal wirings that are adjacent to sides of the reflection plate are not parallel to the sides of the reflection plate.

16. The method of manufacturing an imaging device according to claim **14**, wherein each of the reflection portions includes a reflection plate and a plurality of metal wirings, and wherein at least one of the plurality of metal wirings has a center part having a first film thickness and edge parts having a second film thickness that is smaller than the first film thickness, the center part being between the edge parts.

17. The method of manufacturing an imaging device according to claim **16**, wherein the reflection plate has a center part having one of the first film thickness and the second film thickness, and the reflection plate has edge parts having the other one of the first film thickness and the second film thickness, the center part of the reflection plate being between the edge parts of the reflection plate.

18. An electronic apparatus comprising:

a solid-state imaging device including:

a semiconductor substrate including a light receiving surface;

a plurality of photoelectric conversion parts provided within the semiconductor substrate; and

a plurality of reflection portions provided on a side of the photoelectric conversion parts that is opposite from the light receiving surface;

wherein each of the reflection portions includes a reflection plate and a plurality of metal wirings,

wherein the plurality of metal wirings are disposed in a same layer as the reflection plate,

wherein for at least one of the reflection portions, the reflection plate and the metal wirings of the at least one reflection portion are each in contact with only a same material in a cross-sectional view of the solid-state imaging device,

wherein the same material is in direct contact with the semiconductor substrate having the plurality of photoelectric conversion parts provided within,

wherein the reflection plate does not overlap with each of the plurality of metal wirings and each of the plurality of metal wirings do not overlap with one another in a depth direction of the solid-state imaging device, and

wherein at least one side of each of the metal wirings and the reflection plate are each disposed at a same distance, when measured in a same direction, from an edge of the semiconductor substrate.

19. The electronic apparatus according to claim **18**, wherein the electronic apparatus further comprises a signal processing unit, the signal processing unit configured to perform signal processing on an image signal output from the solid-state imaging device.

20. The electronic apparatus according to claim **18**, wherein a height of the reflection plate is in a first direction in the same layer, and each of the plurality of metal wirings are disposed in a second direction and the plurality of metal wirings do not exceed the height in the first direction, wherein the second direction is perpendicular to the first direction.

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